The implications of using different methods to measure ethnicity in a cohort study

Shirley Simmonds

A dissertation for the completion of Masters in Public Health

University of Otago, Wellington

Shirley Simmonds

2010

shirley.simmonds@otago.ac.nz

Supervisors:

Diana Sarfati

Ricci Harris

CONTENTS

CONTENTS 3
MANAKOTANGA - ACKNOWLEDGEMENTS 9
KUPU MĀORI 11
GLOSSARY and abbreviations 11
ABSTRACT 15
Background 15
Aim 15
Methods 16
Results 17
Conclusions 17
INTRODUCTION 19
BACKGROUND 23
Chapter One: A Kaupapa Māori Approach 23
The Historical Context 23
The Treaty of Waitangi 24
Colonisation 25
Māori Health 26
Kaupapa Māori 29
Kaupapa Māori and Research 32
Kaupapa Māori and Epidemiology 34
Chapter Two: Ethnicity 43
Definition of Ethnicity 43
Self-identified Ethnicity 45
Multiple-ethnic Identification and Ethnic Mobility 48
Ethnicity and Genetics 49
Measurement of Ethnicity 50
Sources of Numerator Data in Health Research 55
National Health Index 55
National Minimum Dataset 56
Mortality Collection 58

Other Sources of Numerator Data 59
Cancer Registry 59
Maternal and Newborn Information System, Mental Health Information National Collection and Primary Care Data 61
Sources of Denominator Data in Health Research 61
Census 61
Methods to Improve Māori Health Estimates in Health Data 64
Methods to Improve Māori Health Estimates - Numerator Data 64
Methods to Improve Māori Health Estimates – Denominator Data 70
Ethnicity data Input and Output 72
Summary – Ethnicity Chapter 78
Chapter three: Study Rationale 79
Philosophical Rationale 79
Measuring Māori:non-Māori Inequalities in a Cohort Study 80
Cohort Study 81
Sensitivity Analysis 81
Possible Impacts of using Different Methods to Measure Ethnicity in this Study 82
1. Different Ethnicity Measures could Identify Different People 82
2. Different Ethnicity Measures could Produce Cohorts of Different Sample Size 84
Specific Aims of this Study 88
METHODS 91
The Unequal Treatment Project 91
Methods for this Dissertation 94
Ethnicity Measures 94
Analysis 97
Cohort Description 97
Age Distribution 97
Population Rates and Ratios 97
Age Standardisation 98
Odds Ratios 99
Hazard Ratios 99
Confidence Intervals and P-values 99
Sensitivity Analysis 100
RESULTS 101
Cohort Description 101
Sex 101

Principal Diagnosis 102
Co-morbidities 102
Age 105
Age Distribution within Cohort *105*
Age 111
Proportion of Māori or non-Māori in each Age Group *111*
Population Rates of IHD 114
Principal Diagnosis 119
Procedure Receipt 123
Procedures Received During First Admission 123
Procedures Received any time after Admission 128
Mortality 133
DISCUSSION 137
APPENDIX ONE 146
Population Denominators 146
APPENDIX TWO 147
2001 Māori Standard Population 147
REFERENCES 148

TABLES

Table 1: Summary of ethnicity classifications, showing time periods over which ethnicity is measured 96
Table 2: Cohort description; patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004. Numbers and age-standardised rates, using different methods to measure ethnicity. 104
Table 3: Patients admitted to hospital for a routine acute ischaemic heart disease event 2000-2004; mean age at admission, by sex, using different methods to measure ethnicity 106
Table 4. Māori patients admitted to hospital for a routine acute ischaemic heart disease event 2000-2004; age distribution, 5-year age group, using different methods to measure ethnicity 109
Table 5: Proportion of Māori in each five-year age group, patients first admitted to hospital for acute routine ischaemic heart disease event 2000-2004, using different methods to measure ethnicity 112
Table 6: Population rates age standardised to 2001 Māori standard population, patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, using different methods to measure ethnicity 117
Table 7: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, Māori:non-Māori odds ratios for principal diagnosis 121
Table 8: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received during first admission – proportional hazard models – EVER MĀORI 125
Table 9: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received during first admission – proportional hazard models –INDEX ADMISSION 125
Table 10: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received during first admission – proportional hazard models – NHI 126
Table 11: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received during first admission – proportional hazard models – RESTRICTED EVER MĀORI 126
Table 12: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received any time after admission – proportional hazard models – EVER MĀORI 130
Table 13: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received any time after admission – proportional hazard models - INDEX ADMISSION 130
Table 14: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received any time after admission – proportional hazard models – NHI 131

Table 15: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received any time after admission – proportional hazard models – RESTRICTED EVER MĀORI 131
Table 16: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004 – deaths from IHD any time following admission. Proportional hazards model (deaths up to 31 December 2006), using different methods to measure ethnicity 134
Table A1. Population denominators derived from 2001 census usually resident population counts. 146
Table A2. Percentage of 2001 Māori standard population in each age group 147

FIGURES

Figure 1: Age distribution of Māori and non-Māori patients admitted to hospital for a routine acute ischaemic heart disease event 2000-2004 using different methods to measure ethnicity 108
Figure 2: Age distribution of Māori and non-Māori FEMALES first admitted to hospital for an acute routine ischaemic heart disease event (2000-2004) using different methods to measure ethnicity 110
Figure 3: Age distribution of Māori and non-Māori MALES first admitted to hospital for an acute routine ischaemic heart disease event (2000-2004) using different methods to measure ethnicity 110
Figure 4: Proportion of Māori in each five-year age group first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004 113
Figure 5: Population rates age standardised to 2001 Māori standard population, patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, using different methods to measure ethnicity 118
Figure 6: Māori:non-Māori odds ratios for principle diagnosis, adjusted for age, and sex, patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004 122
Figure 7. Procedures received during first admission, Māori:non-Māori hazard ratios, adjusted for age and sex, diagnosis and co-morbidities, using different methods to measure ethnicity 127
Figure 8. Procedures received any time after admission, Māori:non-Māori hazard ratios, adjusted for age and sex, diagnosis and co-morbidities, using different methods to measure ethnicity 132
Figure 9: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, deaths from IHD any time following admission up to 31 December 2006. Proportional hazards model, Māori:non-Māori hazard ratios; unadjusted, adjusted for age to 2001 Māori standard population, and sex, and adjusted for age, sex and diagnosis, using different methods to measure ethnicity 135
Figure 10: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, deaths from IHD any time following admission up to 31 December 2006. Proportional hazards model, hazard ratios by diagnosis adjusted for age to 2001 Māori standard population, and sex, using different methods to measure ethnicity 136

MANAKOTANGA - ACKNOWLEDGEMENTS

Tēnei te mihi kau atu kia koutou kua tautoko i ahau i tēnei haerenga. Ngā mihi mahana, ngā mihi aroha ki taku whānau, aku hoa, aku hoa mahi kua awhina i ahau.

Ehara tēnei mahi he mahi takitahi.

I dedicate this dissertation to my son Tamihana who came into the world in the middle of it all.

A huge thank you to his big sister Chloe who stepped up her share of the household chores, and entertained her little brother to allow me time to work.

And the biggest thanks to my husband who has supported me in every way possible.

To my two supervisors: Diana Sarfati and Ricci Harris. Your expertise, patience and understanding have been the foundation of this dissertation! I have been fortunate to have such a fantastic combination of experience and knowledge guiding me through this journey. I have learnt a lot.

To Gordon Purdie, Biostatistician who did the complicated part of producing the numbers for me to analyse. Thank you for your time and expertise, it is really appreciated.

To Donna Cormack for lending your expertise in this area during many informal discussions, and for providing thorough feedback on a draft of this dissertation.

Thank you also to Bridget Robson, principal investigator of the Unequal Treatment Project who reviewed a draft of this dissertation and who has guided me in many ways during my journey into research.

And to all of the whānau at the Eru Pōmare Māori Health Research Centre who cheered along the sidelines; Ruruhira Rameka, Melissa McLeod, Sarah-Jane Paine, Jordan Waiti, Tim Rochford, Anaru Waa, Jeannine Stairmand, Matapihi Kingi. Also to my dear friend Clare Aspinall who provided moral support and reprieve over chocolate and coffee. There are many others also who may not have even realised it, but sometimes even just an encouraging, understanding comment can provide the boost to keep going, or knuckle down and get back into it.

Time is a precious thing, and I thank you all for contributing your time to helping me complete this dissertation.

The Unequal Treatment Project is part of the wider Health Inequalities Research Programme conducted by researchers in Otago University, Wellington. I would like to acknowledge the funding which has come from the Health Research Council and has allowed me to undertake this study towards a Masters in Public Health.

And finally, while analysing data, trawling through columns of numbers, looking for trends and patterns in graphs and tables, I'm constantly mindful of the many whānau members that are represented by the figures on the page. Ultimately this research is for you, and for the generations of our people to come.

Kia ora tatou katoa

KUPU MĀORI

Hapū	Subtribe
Iwi	Tribe
Kaupapa	Theme, topic, subject
Tangata whenua	'People of the land', original inhabitants of a country
Te ao Māori	the Māori world
Tikanga	Traditions, customs, what is 'right' and correct
Tino rangatiratanga	Self-determination, autonomy
Māori	1. Indigenous population of Aotearoa / New Zealand 2. Common, normal, regular

GLOSSARY AND ABBREVIATIONS

ACS	Acute coronary syndrome
Acute routine admission	Admission to hospital that is routine (not transferred from another facility) for an acute event (not arranged via waiting list or private elective)
Angina	Chest pain due to lack of blood and therefore oxygen supply to the heart muscle
Angiocardiography	Examination of the heart and associated blood vessels using x-rays following the injection of a radiopaque substance. A catheter (thin plastic tube) is positioned into a heart chamber by inserting it into an artery, and then into the aorta through which the dye is injected.
Angioplasty	Procedure whereby a balloon is inserted to reopen a blocked artery (also known as percutaneous coronary intervention)

Angioplasty with stenting	As above for angioplasty, with a permanent stent that is put in place to hold the artery open once the balloon is removed
CABG	Coronary artery bypass graft. Arteries or veins from elsewhere in the body are grafted to the coronary arteries to improve the blood supply to the heart muscle
Catheterisation	Use of a catheter (thin plastic tube) to inject dye into the heart chamber so that the blood flow or blockages can be viewed using an x-ray.
EM	'Ever Māori' method of assigning ethnicity – if a person has ever been identified as Māori in any hospitalisation, death record or other data source, they are assigned Māori ethnicity in a study
IHD	Ischaemic heart disease
HNZC	Housing New Zealand Corporation
Index admission	First admission to hospital for particular condition. In this dissertation, ethnicity stated on index admission for ischaemic heart disease event is used as one of the methods to measure ethnicity.
KM	Kaupapa Māori
MHINC	Mental Health Information National Collection
MI	Myocardial infarction (heart attack)
MI unspecified	Myocardial infarction not specified as to whether it is ST-elevated or not
MNIS	Maternal and Newborn Information System
NHI	National Health Index
NZCMS	New Zealand Census Mortality Study
PCI	Percutaneous Coronary Intervention (also known as angioplasty), procedure whereby a balloon is inserted to reopen a blocked artery.
Restricted Ever Māori	A method of measuring ethnicity in this dissertation whereby an individual is classified as Māori if they are Māori on any hospital admission from 1988 up to and

	including first admission for acute routine IHD event between 2000-2004
STEMI	ST-elevated myocardial infarction (more severe than non-STEMI)
Unstable angina	A type of angina that is irregular

ABSTRACT

Background

Māori have the right to good health and healthy conditions. The colonial history of Aotearoa has led to an unequal distribution of privilege and disadvantage in our society, which in turn has created and maintained persistent disparities in health.

The ability to measure and monitor health inequities in health is vital to upholding the right to good health for all and ensuring governmental obligations to promote equity are met. This necessitates ethnicity data of high quality and the reassessment of epidemiological methods and practices to ensure their appropriateness for tangata whenua. Kaupapa Māori research provides the mechanism for the critique of epidemiological tools, and therefore it is through a Kaupapa Māori lens that this dissertation has assessed the use of different ethnicity measures.

Previous studies have been done to determine the impact of varying the method used to measure ethnicity on population rates. This dissertation examines the effect in a cohort setting. The cohort study is part of a wider project that aims to determine the impact of unequal treatment in the health system on Māori with ischaemic heart disease.

Aim

The overall aim is *to determine the impact of four different methods used to measure ethnicity in a cohort study.* The hypothesis is that there will be little or no impact on the results of the study.

The specific objectives of the dissertation are:

1. to conduct a sensitivity analysis using four different methods to measure ethnicity in a cohort study.
2. to explore the effect of using different methods to measure ethnicity on cohort characteristics and key study outcomes

Methods

A cohort of all individuals admitted to hospital 2000-2004 with a primary diagnosis of angina or myocardial infarction was identified. Patients were followed to the end of 2004 for receipt of cardiac procedures or death.

Logistic regression modelling was used to calculate odds ratios for the odds of receiving cardiac procedures or death for Māori and non-Māori patients. Proportional hazards regression was used to calculate hazard ratios in order to compare the relative chance of receiving procedures or of death after admission.

The analysis was conducted a total of four times using the following methods to measure ethnicity. An individual was counted as Māori if they were identified as Māori on:

1. any hospital admission 1988-2004 or cancer registration, National Health Index or death registration 2000-2006 (‘ever Māori’)
2. their first hospital admission for an acute routine IHD event between 2000-2004 (‘index admission’)
3. their National Health Index number as at 20 February 2006 (‘NHI’)
4. any hospital admission or cancer registration from 1988 up to and including first admission for an acute routine IHD event between 2000-2004 (‘Restricted ever Māori’)

Characteristics of the four cohorts defined using the different ethnicity measures were compared. These included age structure, gender, principal diagnosis and co-morbid conditions.

Results

The hypothesis was largely confirmed. It was found that using the four different methods to measure ethnicity had little or no impact on the results of the study, and did not change the interpretation of the study results.

There were slight variations in the numbers of Māori generated using the different ethnicity measures, possibly defining groups with slightly different characteristics. The reasons for these differences will be discussed.

Conclusions

This sensitivity analysis has provided more rigour in the choice of method used to measure ethnicity in the unequal treatment study, and will also inform future analyses.

This study contributes to the developing field of Kaupapa Māori Epidemiology, an epidemiology that acknowledges the right of Māori to assess how they are being represented in health data, and promotes the critique of epidemiological methods to ensure they best serve Māori aspirations and priorities.

INTRODUCTION

Upholding the statistical rights of indigenous peoples provides the moral imperative for developing robust epidemiological practices. The imbalance of power and control and consequent unequal distribution of privilege and disadvantage in society between Māori and non-Māori citizens of Aotearoa[i] has created and maintained persistent disparities in health. There is a strong governmental obligation to eliminate disparities in health (Ministry of Health, 2002b, 2002c) and ensure the right to the highest attainable standard of health for all citizens of this country is met (CERD, 2007; P. Hunt, 2006; United Nations, 2007).

The ability to measure and monitor health disparities is crucial to fulfilling this right. There are ongoing challenges in producing high quality and appropriate ethnicity data in health statistics, (Cormack & Harris, 2009; Public Health Intelligence, 2001a; Te Rōpū Rangahau Hauora a Eru Pōmare, 2000) and epidemiological tools must be critiqued in order to ensure they are serving Māori best (Robson, 2005; Robson, Cram, Purdie, & Simmonds, 2007). Māori have the right to determine their own representation in health data.

In Aotearoa, ethnicity is a routinely collected variable in health datasets. However, there remains variation in the ways in which this information is gathered, processed and utilised. The Ministry of Health has produced ethnicity data protocols for the Health and Disability Sector intended to improve and work towards standardising ethnicity data collection, input and output (Ministry of Health, 2004a). Unfortunately there is still evidence that Māori are undercounted on some health datasets (Harris, Purdie et al., 2007; Shaw, Atkinson, & Blakely, 2009). Often this produces a numerator-denominator bias in the production of population rates due to different approaches to ethnicity data collection and variation in ethnicity data quality between the numerator and denominator sources. This results in underestimates of Māori

---

[i] New Zealand

rates of adverse health outcomes. Some methods have been developed to correct for this undercount in order to produce ethnic specific rates that more accurately reflect Māori health status (Ajwani et al., 2003a; Ajwani, Blakely, Robson, Atkinson, & Kiro, 2003b; Harris, Purdie et al., 2007). Two common approaches are used; 'adjusters' and 'ever Māori' approaches.

Adjusters have been calculated by matching data that is known to undercount Māori with data of better quality such as the census (Ajwani, Blakely, & Robson, 2004; Harris, Purdie et al., 2007; Ministry of Health, 2010; Shaw, Atkinson, & Blakely, 2009; Shaw, Atkinson, Blakely, Stanley, & Sloane, 2009). These adjusters can be applied to population data at an aggregate level in order to improve the quality of the estimates for Māori. However they cannot be applied at an individual level, such as for a cohort study.

The 'ever Māori' method involves the reassignment of ethnicity and can take place at an individual level. By linking multiple health data sets, an individual is counted as Māori if they were ever recorded as Māori in any cancer registration, hospital admission or death registration or on the NHI (Cormack & Harris, 2009). This method has been applied in some key health reports in Aotearoa to adjust for undercount of Māori (Ministry of Health, 2006a; Robson, Purdie, & Cormack, 2006). Ethnicity data is not altered on the original data source (such as the NHI or death registration), it is only changed in the dataset for the purpose of the study being conducted.

There has been less work carried out on the potential impact of measuring ethnicity at an individual level in a cohort study. While the matter of numerator-denominator mismatch will not be an issue so long as an internal denominator is used, it is still important to investigate the effect of measuring ethnicity using different methods.

The intention of this dissertation is to 1) discuss the importance and rationale of Kaupapa Māori research, particularly in epidemiology, 2) discuss issues relating to measuring ethnicity in research in general and in Aotearoa specifically, 3) to describe methods that have previously been used to improve estimates of Māori data in the

calculation of population rates, and 4) to determine the impact, if any, on measuring ethnicity using four different methods within a cohort study designed to determine the contribution of the presence of co-morbidities to disparities in cardiac procedure receipt for Māori.

Cohort studies are a commonly used study method in epidemiology but there is little or no research assessing the impact of different methods of measuring ethnicity in cohort studies. It is hoped that this study will work towards developing more robust techniques for measuring ethnicity in cohort studies conducted in Aotearoa. Given that there will be no numerator-denominator mismatch, it is not expected that major differences will be found in this study with the use of different methods to measure ethnicity. However studies on ethnic disparities in health must be able to justify choice of method used to measure ethnicity, and this study will add to the information required to make this choice.

Overall this dissertation intends to contribute to the developing field of Kaupapa Māori Epidemiology - an epidemiology that centralises Māori realities and priorities and is responsive to the demographic circumstances of the indigenous population of Aotearoa. Māori have the right to high quality statistical data and to critique the statistical tools and methods used to produce this data. Each of the ethnicity groupings in the cohort study represents Māori. Māori have the right to assess how they are being represented and what impact that might have on study results, and in turn, on decisions in health and health policy that determine the health futures of tangata whenua.

Data on health inequities potentially have the power to determine priorities, planning, funding and strategic direction in the health system and thus contribute greatly to effecting positive change for Māori. The development of robust epidemiological techniques to generate this data is crucial for appropriate representation of Māori health status.

BACKGROUND

Chapter One: A Kaupapa Māori Approach

This dissertation intends to take a Kaupapa Māori approach. The first chapter therefore will provide context for the research, detailing the philosophical foundations of Kaupapa Māori, why they are necessary in a modern context, and the fundamental principles that inform Kaupapa Māori theory. It begins with an overview of the historical circumstances of this country, the development of Kaupapa Māori theory, and its place in research and in epidemiology.

The Historical Context

If a society consisted of only one ethnic group, there would be no need for that group to articulate to one another its beliefs, values, standpoint and basic philosophies upon which its society is structured.

However, when two or more ethnic groups coexist in a country, there is not necessarily a shared understanding between these groups. This can be further complicated by a history of colonisation, disempowerment, disenfranchisement, assimilation and domination by one group over another. This often results in one group, the colonising group, being the numerically dominant population in a country, the stronger political power, and the more pervasive research voice.

Originally the indigenous population of Aotearoa had no name for themselves as a people as there was no need for one. With the arrival of another people in the 1800s, they described themselves as 'māori' or ordinary, regular, normal and therefore, as a people, became known as Māori (Broughton, 1993; Moewaka-Barnes, 2000; Orange, 2004; Pipi, 2004; H. W. Williams, 1992).

Over time in this country, being 'Māori' (indigenous to Aotearoa) became less 'māori' (common, regular, normal). In the early 1800s, following increasing settlement of Aotearoa by the British, Māori sought to protect and secure their sovereignty. The Crown sought to establish some level of law and order. For these reasons, among others, The Treaty of Waitangi resulted.

The Treaty of Waitangi

The preamble of the Treaty indicates the overall intent to protect the rights and property of Māori (Durie, 1998; Reid, 1999a). In the English version, article one transfers sovereignty of this country to the British Crown and article two guarantees existing property rights and that Māori would not be alienated from their land and resource base. Article three guarantees equity between Māori and other citizens of Aotearoa (Durie, 1998; Reid, 1999a).

However, in the version written in te reo Māori, the version signed by most Māori signatories, article one transfers *governance* or kawanatanga (rather than sovereignty) to the British crown, and article two guarantees tribal authority (tino rangatiratanga) over 'taonga'. The literal translation of 'taonga' is 'treasures' or things that are precious and of value. Using this interpretation, taonga can include cultural, social and economic resources, material properties, and also encompasses among other things, the health of the indigenous people (Durie, 1998). Article three has a direct implication for health, and denotes the imperative for the Government to strive for equity in the health system and other areas of society (Reid, 1999a). While it is useful to interpret the Treaty article by article, this can sometimes limit its application (Robson & Reid, 2001). The right to tino rangatiratanga (Māori sovereignty), forms the basis of each of the articles, and therefore of the Treaty as a whole.

In the past, the Treaty has largely been dishonoured. At an operational level today, three principles derived from the Treaty are often applied. The principle of *partnership* refers to an agreement between iwi or hapū and the Crown, or more

commonly, a working relationship between Māori and government agencies (Durie, 1998). The principle of *participation* refers to Māori involvement in a particular activity or sector and the principle of *protection* denotes the Crown's obligation to remedy past mistakes through measures which will benefit Māori (Durie, 1998; Royal Commission on Social Policy, 1988).

These principles place an obligation on the Crown to include Māori in the design of health legislation, policies and strategies, and make provision for Māori to be actively involved in health planning, decision making, priority setting, resource allocation and the delivery of health services. In health the government has an obligation to intervene positively. Several recent governmental health documents have given recognition to the indigenous status of Māori and acknowledged the Treaty as fundamental to the relationship between Māori and the Crown (Ministry of Health, 2002b, 2006a). Māori have rights to a say in the way that policy decisions are made and resources distributed (Linda Tuhiwai Smith, 1999b).

Colonisation

It is estimated there were 80,000 Māori and 2,000 Pākehā in Aotearoa at the time of the Treaty signing in 1840. By 1858 both populations were roughly equivalent, numbering approximately 59,000 each (Pool, 1991). Following this time, the settler population continued to grow and began to outnumber the indigenous population, with Māori becoming a minority in their own land to the point where it was predicted they would 'die out' (Pool, 1991; Linda Tuhiwai Smith, 2007). Depopulation due to disease, lifestyle and dietary changes, urbanisation, destruction of resources and disruption of whānau and communal living, saw the Māori population further diminish and simultaneously the European population flourish as immigration continued and settlers thrived in the new country (Durie, 2003b; Pool, 1991; Reid, 1999b).The high morbidity and mortality rate of Māori following contact was further compounded by dispossession of land, the very event against which the Treaty was supposed to protect. This promoted environments of poverty, overcrowding and malnutrition for Māori, and diseases flourished under these conditions (Durie, 2003b; Reid, 1999a).

Colonisation ultimately involves the loss of sovereignty by one group to another group. It is a process whereby power and resources are re-distributed to the new inhabitants of a country, essentially transforming the nation; demographically, politically, economically and socially, and depriving the indigenous population of their rights (Jackson, 1996; Reid & Cram, 2005; Reid & Robson, 2007). In Aotearoa, settlers conferred power to themselves and established new systems and structures based on ethnocentric ideals which are therefore fundamentally racist. A range of legislative initiatives instituted by the new colonial government contributed to marginalisation of Māori and took their toll on population numbers. What Māori considered 'normal, regular, ordinary' has been denormalised over time, and a new 'normal' has resulted. Māori have been marginalised, minoritised and constructed as the 'other' in their own country (Cram, 2004a).

Colonisation is not a discreet event confined to the past. It continues today, albeit often in a less explicit and obvious manner. Systems set up by the colonising culture automatically perpetuate the ongoing decentralisation of Māori. There exists today an unequal distribution of power and control in this country and Māori aspirations are pushed to the periphery of society's consciousness.

Māori Health

The power imbalance in Aotearoa ensures that the numerically dominant population has a privileged position in today's modern society, enjoying better health, wealth, housing, education and political status than the indigenous population (Ajwani, Blakely, Robson, Tobias, & Bonne, 2003c; Cram, 2004a; Robson & Harris, 2007). The health status of Māori is now well documented (Ajwani et al., 2003c; Ministry of Health, 2010; Robson & Harris, 2007). Māori have a lower life expectancy, higher rates of death and disease and lower rates of access to health services for most indicators of health. Māori experience many illnesses more severely, at an earlier age, and experience delays in diagnosis (Ministry of Health, 2010; Robson & Harris, 2007).

The reasons for health inequalities are complex, and involve external structural influences, often beyond the control of individuals and groups in society that are affected by poor health. Wider determinants of health such as social, political, economic, cultural and historical factor impact upon a person in a complex fashion that may not be immediately apparent (D. R. Williams, 2008).

Poor health and health disparities however, are often attributed to lifestyle and behavioural factors or to a genetic predisposition, a view that Nancy Krieger refers to as 'the racialised expression of biology' (Krieger, 2001). Such narrow-focussed explanations can perpetuate in society a 'victim-blaming' mindset, which centres on the individual and in so doing, diverts attention from structural factors and the obligations of the Crown to ensure the right to health for all is fulfilled. Māori have been construed as the 'problem' in explanations of disparities, (Reid, Robson, & Jones, 2000) which unfortunately is a common discourse applied to colonised indigenous peoples (Linda Tuhiwai Smith, 1999b).

In many ways, Māori are represented as 'different' from 'ordinary' New Zealanders and therefore constructed as the 'other' in society's discourse (Reid et al., 2000). This can be seen in examples where the health of the *total* population is focused on, such as in many reports distributed by the Crown. Māori data is swamped by the numerically dominant ethnic group, and the resulting data of the total population is presented as representative of all New Zealand.

By framing Māori as the 'culprit' and laying blame on either; genes, culture, intellect, socio-economic status, individual behavioural patterns, or 'luck', retains the focus on Māori. This 'deficit theory' framework is limited and inadequate in that it does not critique the role of society or structural issues in the manifestation of disparate health (Robson & Reid, 2001; Linda Tuhiwai Smith, 1999b). It ignores system and structural bias, ensuring outcomes for non-Māori are never closely examined, Pākehā privilege never exposed and the preferential benefits experienced by Pākehā from the systems introduced and built by themselves are never challenged (Reid & Robson, 2007).

In a racialised society, the impact of our social environment on health is referred to by Nancy Krieger as the 'biological expressions of racism' (Krieger, 2001). Krieger and colleagues argue that our social environment and hierarchies within, affect our bodies just as our physical environment does, shaping what we know, how we perceive the world, our level of access to societal resources and our ability to navigate through social systems – all factors which ultimately impact upon our well-being, and are therefore expressed biologically.

Racism is now more widely recognised as a determinant of health. In Aotearoa there is direct evidence of the link between experience of racial discrimination and poorer health outcomes, with Māori respondents in a national survey reporting the highest levels of racial discrimination (Harris et al., 2006a; Harris et al., 2006b). Any adverse health outcomes as a result of racism will therefore disproportionately impact on Māori.

Access to and through the health system and to the wider determinants of health such as education and employment, play a large part in the health status of Māori. Many of the health conditions that Māori are afflicted by are readily amenable to treatment, and Māori experience much higher rates of avoidable mortality and hospitalisations than Pākehā (Ministry of Health, 2010; Robson & Harris, 2007). Barriers to accessing health services and failure of services to meet Māori needs are largely implicated in these statistics (Reid, 1999b).

While socio-economic factors are considered primary determinants of health and there is evidence of disparities in these determinants with Māori over-represented in lower socio-economic groups, they do not account for *all* ethnic disparities in health. Nancy Krieger has concluded that both socioeconomic position *and* ethnicity need to be considered when investigating social patterning of disease (Krieger et al., 2006). Camara Jones states that we should 'never accept socio-economic status as an 'explanation' of Māori and non-Māori health disparities. That would be accepting as a given the differences in the distribution of socio-economic status between Māori

and non-Māori' (Jones 1999, cited in Robson and Reid 2001 (Robson & Reid, 2001)).

Some research has found that quality of care differs by ethnicity (Davis et al., 2006; Hill & Sarfati, 2010; Jeffreys et al., 2005; Stevens, Stevens, Kolbe, & Cox, 2008; Westbrooke, Baxter, & Hogan, 2001). Camara Jones (2000) identifies three main pathways that contribute to ethnic inequalities in health; differential access to the determinants of health, differential access to health care and differences in the quality of care received (CP. Jones, 2000).

Although brief, this description of health disparities in Aotearoa gives some insight into the complexity of the factors that contribute to the health of the indigenous population. A deeper understanding of these factors is evolving in recent years, and understanding the pathways that perpetuate and maintain inequalities can help us to visualise the pathways for improvement. Quite simply, there needs to be a change for the better in terms of health for Māori. The mechanisms for this change are firmly based in tino rangatiratanga.

Kaupapa Māori

To effect positive change for Māori, there needs to be acknowledgement of the historical context of our country, and recognition of the need for Māori to regain tino rangatiratanga in all aspects of society. Kaupapa Māori has in part provided the mechanism for this, allowing the necessary creation of space for Māori realities (Pipi, 2004; G. H. Smith, 2003).

There is no set, universal definition of Kaupapa Māori, and indeed it has been stated that an attempt to construct one would be 'antithetical to the fundamentals of Kaupapa Māori' (IRI (International Research Institute for Māori and Indigenous Education) & Te Rōpū Rangahau Hauora a Eru Pōmare, 2000) Therefore this

dissertation won't set out to provide a definition, rather outline some of the key elements and applications of Kaupapa Māori theory.

Kaupapa Māori has evolved to cover a broad spectrum of understanding, but the central tenets are relatively consistent. Tino rangatiratanga lies at the very core, with the aim to achieve self-determination in whatever capacity possible within the disciplines that Kaupapa Māori is applied, and across society as a whole. There is a need and desire by Māori to have increased control over one's own life and cultural well-being (G. H. Smith, 2003).

Kaupapa Māori forms a way of resisting oppressive colonial structures in society and offers a counter-hegemonic paradigm (Henry & Pene, 2001). In so doing, it is a tool of decolonisation, and correctly utilised it has the potential to be a powerful tool of change. Kaupapa Māori reasserts that to be Māori is normal, (Pipi, 2004) and therefore recentralises Māori priorities, aims and aspirations. Kaupapa Māori is essentially a 'Māori way, (Taki, 1996) and therefore allows us to question and critique westernised notions of what may have become accepted as 'normal' and 'common sense'.

Graham Smith (cited in Smith 1999 (Linda Tuhiwai Smith, 1999b)) states that Kaupapa Māori is related to 'being Māori', is connected to Māori philosophy and principles and is concerned with the struggle for autonomy over our own cultural well-being.

It is this struggle for autonomy that has led Kaupapa Māori to come to the forefront in recent years. In the last few decades, recognition that the education system was not serving Māori, led to a revolution in the 1980s where Māori communities set up their own learning institutions initially at pre-school level, then primary secondary and tertiary. The conviction that *'we can't do any worse than the system is currently doing'* forced Māori communities outside of the constraints of the existing system (G. H. Smith, 2003).

In his PhD thesis, Graham Smith lists some key elements of Kaupapa Māori that contributed to the success of the indigenous schooling movement (G. Smith, 1997; G. H. Smith, 2003). While these pertain directly to education, they can have wider application to other disciplines and are summarised as follows:

Kaupapa Māori:

- promotes the validity and legitimacy of Māori language, knowledge and culture
- creates the political space to enable legitimate study and continuance of Māori language, knowledge and culture
- is positioned as Māori centred
- is concerned with economics and structural change
- attempts to take account of unequal power relations and dominant / subordinate politics
- is transformative in its aims
- challenges existing theory
- supports the use of all existing theory (by Māori) providing that it can positively support Māori advancement
- recognises that indigenous struggle is needed on several levels and in several sites, often simultaneously

A key theme is the element of change and transformation. Kaupapa Māori therefore recognises that Māori need not be bound by the (colonial) structures that exist in Aotearoa, and that change is possible and necessary. Resistance and intervention strategies that evolve from this basis can respond to multiple formations of oppression and exploitation (G. H. Smith, 2003).

Graham Smith further describes the process of transformative action, which involves *conscientization* (recognition and awareness of oppression), *resistance* (to existing colonising structures), and *transformative action* (effecting change). These three stages are interlinked, not linear and do not happen in any set order (G. H. Smith, 2003).

While Kaupapa Māori has its origins in education (Russell Bishop, 1998) it has since extended into various other areas including health. A Kaupapa Māori model of practice has been applied in health services, social services, mental health and psychology, and several other disciplines (Abel, Gibson, Ehau, & Leach, 2005; Herbert, 2002; Owen, 2001; Walker, 2004).

There have been some who query whether Kaupapa Māori approaches in health services (for example) 'work'. There have been calls for evaluation of services, and 'proof' that Māori health is improving as a result of these services. What we do know, is that the system in place previously *wasn't* working for Māori, and this is reflected in the unequal health status between Māori and non-Māori. Under the Treaty of Waitangi, Māori have the right to self-determine and therefore the right to decide the structure of the health service that best suits their own needs. To impose upon a Kaupapa Māori service an evaluation model that follows another framework, could in fact be viewed as a breach of this right and obstructive to Māori autonomy in health. Subsequently, Kaupapa Māori evaluation processes have been implemented (Pipi, 2004).

Māori have the right to good health and healthy conditions. This is a basic human right for all, (P. Hunt, 2006) but is also a specific right for indigenous peoples conferred by the United Nations Declaration on the Rights of Indigenous Peoples of which Aotearoa is a signatory (United Nations, 2007). Even more specifically for Māori, it is a right accorded by the Treaty of Waitangi with its guarantee of equity for all citizens of Aotearoa (CERD, 2007). Kaupapa Māori allows us space to assert these rights and address breaches of the Treaty of Waitangi (Cram, 2009).

Kaupapa Māori and Research

As a research methodology, Kaupapa Māori has been applied across various disciplines, not only health and education, but also subjects as diverse as tourism and accounting (Edwards, McManus, & McCreanor, 2005; H. Hunt, Morgan, &

Teddy, 2001; McNicholas & Barrett, 2003; Zygadlo, McIntosh, Matunga, Fairweather, & Simmons, 2003).

Kaupapa Māori theory in research is not new. Our tupuna had a way of understanding the world and generating new knowledge (Reid, 1999a) – Kaupapa Māori is about reclaiming this inherent research culture and reapplying the philosophies and principles today in a modern context. What is new is the need to give it a name – necessitated in the same way that the word 'māori' was used to describe what was considered normal and usual.

Research in Aotearoa, and indeed in many other countries, has been used as a tool of colonisation and marginalisation, leading to considerable distrust. As Linda Smith states; 'research was an important part of the colonisation process because it defines what legitimate knowledge is' (Linda Tuhiwai Smith, 1999b). However, research is one tool that can be used to de-marginalise and re-centre Māori priorities (Cram, 1993). The role of Kaupapa Māori research is to affirm Māori worldviews and critique colonial constructions of Māori (Cram, 2009). At the centre of all Kaupapa Māori research is the betterment and benefit of Māori. Research should always seek to enhance Māori cultural, social and economic well-being (G. H. Smith, 2002). Māori should be prioritised in all aspects of research; from the development of research questions, the choice of methods and methodologies and how they are implemented, to the processes used and the dissemination and framing of research results. Kaupapa Māori research should be empowering for Māori.

Ideally, Kaupapa Māori research should be conducted by Māori for Māori with Māori, (Cram, 2004a; Henry & Pene, 2001) although there can be a place for non-Māori researchers also (L T Smith, 2005). Kaupapa Māori research should, however, be controlled and defined by Māori. Our right to develop processes of research appropriate for our people is affirmed by the Treaty (Jackson, 1996).

Kaupapa Māori and Epidemiology

The recognition that the education system was not meeting the needs of Māori spurred the development of Kaupapa Māori in education; similarly, it has been argued that persisting disparities in health are evidence that medical research to date has 'failed' to address the needs of Māori (Linda Tuhiwai Smith, 1999b). Health research and epidemiology provide powerful data that informs decision-making processes in policy, planning and funding (Robson, 2005; Robson et al., 2007) and can essentially decide who gets what and how much and who goes without. While much of the literature regarding Kaupapa Māori research relates to, and has obvious application to, qualitative research, (Cram, 1993, 2009; Keefe, Ormsby, & Robson, 1995; L. Smith, 1999a) the fundamental philosophies can also definitely be applied in a quantitative setting using a Māori defined analytical framework that is responsive, reflexive and accountable (Edwards et al., 2005). Applying a 'methodology' - philosophical approach that determines the way we undertake research - that is firmly grounded in Kaupapa Māori philosophies, we can scrutinise statistical 'methods' – tools that can be used to produce and analyse data. In this way too, the benefits of epidemiological methods can be utilised provided they are applied within a Kaupapa Māori framework.

In the past, statistics have been used against Māori and many Māori have become wary of research and the potential damage it can do (Linda Tuhiwai Smith, 1999b). This caution extends to the 'numbers' involved in research data. It has sometimes been remarked in the Hauora Māori research circles the sense of 'numberphobia' in the Māori community with a tendency of some Māori to reject statistics and research, a wariness borne of a colonised past where negative statistics of health (and other areas) contributed to the negative portrayal of Māori.

Added to this is the low representation of Māori in disciplines involving Maths and Science (McKinley, Waiti, & Bell, 1992). With respect to science subjects in schools, research has identified that barriers to Māori student success include deficit theorising, resulting in low teacher expectations of Māori students (R Bishop & Berryman, 2006). Over time, generations of Māori have now come through the

education system with these low expectations of achievement placed on them by teachers and others in positions of power (Rubie-Davies, Hattie, & Hamilton, 2006). This low representation of Māori in fields of Science and Maths, can add to the 'mystification' of these subjects for Māori.

Papaarangi Reid, in her presentation entitled *'Stats R Us'* speaks of 'reclaiming numbers and decolonising data' (Reid, 2008). She asserts the need for Māori to reclaim Science, including Maths and Statistics. Through the process of colonisation, western research has been elevated and indigenous knowledge relegated to a position of lesser importance. To counteract these effects of colonisation, Reid states we need to:

- reject colonising discourses
- name racism and privilege
- reclaim our rights to: quality data, quantitative data and good analyses
- tell the story of the data

Māori have been misrepresented in the past; cultural rationales have been put forward to 'explain' differences between Māori and non-Māori in health, Māori have been blamed for their 'shortcomings' and disparities have been attributed to differences in socioeconomic status (Robson & Reid, 2001). There is a need therefore for Māori to decide their own representation – and 'tell the story of the data'. Kaupapa Māori research shifts the gaze and places 'under the microscope': the Crown, society as a whole, services (health, social, justice) and those who are privileged (Reid, 2008).

Epidemiology is a dynamic and evolving field. There is recognition of the need for new methods to be developed (Neil Pearce, 1999). Through Kaupapa Māori we can adopt a critical stance and reassess and challenge current epidemiological methods and practices. This may reveal the need for new methods or alteration of existing methods. It may involve applying existing methods, unaltered, in a Kaupapa Māori framework so that the benefits of epidemiology may be utilised to progress Māori aspirations. At the very minimum, it will involve gaining a deeper understanding of epidemiological practices and tools and their application to Māori.

To fulfil indigenous rights to good health and healthcare, appropriate, high quality data is required. Policy is guided by trends and disparities in mortality, morbidity and service utilisation in both the health sector and other sectors that influence the wider determinants of health (Robson, 2005). The epidemiological tools and processes used to generate these data require close scrutiny with a Kaupapa Māori lens in order to assess their appropriateness for Māori. This critique has begun to occur in recent years, and has seen the development of some strategies that can be applied in epidemiology.

To start with, complete and consistent collection of ethnicity data is essential (Bramley et al., 2004a; Robson, 2005). A standardised ethnicity question across the health sector, and other sectors that impact upon health is required. Data collection systems must be adequate and capable of collecting and recording the appropriate data required, the way in which ethnicity data is coded and stored should also be standardised (Bramley et al., 2004a; Robson, 2005). Māori (and indeed, people from all ethnicities) have the right to self-identify their ethnicity (Robson, 2005). Ethnicity data collection and recording should allow for self-identified ethnicity. These issues are outlined in the Ethnicity Data Protocols, (Ministry of Health, 2004a) and will be explored further in the next section on ethnicity.

Comparisons made between Māori and non-Māori populations are consistent with a Kaupapa Māori approach, (Bramley et al., 2004a) and are often used to obtain a picture of the balance of disparities and privilege in health. To further categorise the non-Māori population into ethnic groupings is not always necessary, however this depends on the research question. For example, if we are looking at white privilege, it may be appropriate to disaggregate the non-Māori group to distinguish a NZ European ethnic group for comparison.

The concept of *'Mana Whakamarama'* or equal explanatory power advocates for equal numbers of Māori and non-Māori subjects in New Zealand survey samples (Robson, 2002). As Māori comprise approximately 15% of citizens in Aotearoa, simple random sampling of the population will produce study results that largely

reflect the experience of non-Māori. Māori have the right to be represented to the same breadth and depth as non-Māori in epidemiological studies (Robson, 2005).

The concept of equal explanatory power has been taken up by the government, for example it has been used in the NZ Health Monitor (Ministry of Health, 2002d) and in other research (Mihaere et al., 2009; Paine, Gander, Harris, & Reid, 2007).

A common statistical tool that has been assessed for its appropriateness for Māori is the practice of age standardisation. The choice of standard population used when standardising for age is usually thought to be arbitrary, however it has been shown to make a difference to the representation of study results from which policy choices can be made (Robson, 2005; Robson & Purdie, 2007).

One study age standardised Māori and non-Māori mortality data (1996-2000) to three different standard populations – Segi's world standard population, WHO world, and the Māori population (mid-year resident Māori ethnic group population 1996-2000). It was found that the choice of standard population used made a difference to the magnitude of age-standardised mortality rates, ratios, rate differences, ranking of causes of death, and the variance on the rates (Robson et al., 2007).

The Māori population has a very young age structure and mortality is strongly associated with age. In general, use of an 'old' population standard such as Segi's or the 'older' WHO world standard, will produce a high standardised mortality rate, and the use of a young population standard such as the Māori standard, will lead to a low overall rate. In the study by Robson et al (2007), the Māori data standardised to the Māori population standard closely approximated crude rates, thus centralising the Māori experience as is befitting of a Kaupapa Māori method. In addition, by applying the Māori standard population, less error is generated in estimates of mortality rates as standardised data closely represents real rates for Māori. It was concluded that the standard used impacts on disparities data between Māori and non-Māori and could potentially influence health policy (Robson et al., 2007).

Following this study, an indigenous population standard was proposed, and has been utilised in key health publications in Aotearoa, and even applied to health data of a non-indigenous population, in this case Pacific peoples in this country (Simmonds, Robson, Cram, & Purdie, 2008). While the stability of the standard over time requires further examination, the ethical incentive for setting an indigenous standard remains.

To use Graham Smith's explanation of the process of transformative action, (G. H. Smith, 2003) these recent advances in epidemiology can provide illustrative examples of this process in practice. Considering both *equal explanatory power* and the development of an *indigenous population standard*;

Conscientization

- recognition that Māori were being inadequately represented in survey samples
- recognition that use of different standard populations changed representation of Māori health data

Resistance

- advocating against use of existing sampling strategies
- challenge use of current standard populations

Transformative action

- development and implementation of equal explanatory power
- development and implementation of use of 2001 Māori standard population

In each case, the proposals for transformative action have been scientifically tested through the epidemiological studies described. While they are grounded in the cultural imperative for change and upholding indigenous rights, they are also 'validated' in a statistical sense and therefore likely to be more readily accepted in the field of health research and epidemiology.

This can lead to transformative action being implemented without the steps of conscientisation or resistance. For example, the 2001 Māori standard population might be applied by a statistician without a greater awareness of the moral imperative for the development of the standard. Conscientisation might follow, or it might not. This is an important part of the process of normalising indigenous standards and recentering, in this case, Māori aspirations.

These relatively recent studies demonstrate a newly emerging, growing field of indigenous epidemiology in Aotearoa. However, the field of epidemiology is vast. While disparities persist, and monitoring is required, a continued focus on furthering the development of indigenous methodologies and methods is warranted. Indeed, even should we reach a point where disparities were eliminated, the imperative to monitor health status over time would remain and there would therefore still be a need for high quality research that centralises indigenous aspirations and realities and rights to good health. Kaupapa Māori is well established in the qualitative research world, yet there is a need for its further development in quantitative research.

Leonie Pihama has deplored the limited contributions of Kaupapa Māori to academic literature in recent times.[ii] She suggests that a strong presence in the literature can serve to reify and reiterate Kaupapa Māori, in a setting that is dominated by western paradigms. Epidemiology should be reflexive and responsive to the needs of the people it describes and serves. This section has highlighted some areas of epidemiology that do not currently meet the needs of Māori. We need to push the boundaries of modern epidemiology and challenge and critique the methods and tools used so that data of the highest quality can be produced for Māori using robust statistical practices.

As Bridget Robson (Robson, 2005) states, all research in Aotearoa must recognise and uphold the rights of Indigenous Peoples. As Māori, we have:

[ii] Leonie Pihama, personal communication. Workshop on Kaupapa Māori theory, Otago University, Wellington August 2008

- the right to define ourselves
- the right to count and be counted
- the right to self-determination
- the right to monitor the State and structures
- the right to health and wellbeing.

Māori have the right to determine their own health futures. Kaupapa Māori seeks to reduce the colonising aspects of health research by critiquing existing epidemiological tools and where necessary developing robust statistical techniques and standards that centralise Māori priorities, and therefore best serve the indigenous population of Aotearoa.

To begin to assess whether an epidemiological process aligns with Kaupapa Māori principles, we might ask of that method or methodology:

- Does it place the needs and aspirations of Māori at the centre?
- Does it allow for Māori self definition?
- Are the demographic characteristics of Māori fully recognised?
- Are Māori fully and appropriately represented?
- Will it contribute to positive change for Māori?
- Does the study enhance self-determination or tino rangatiratanga?

If it meets these criteria, this is not evidence of suitability in its entirety, rather a step in the right direction.

This dissertation uses a Kaupapa Māori approach. It aims to gain a better understanding of methods used to measure ethnicity, and methods developed to improve Māori health estimates in a cohort study setting. This will enable a more detailed insight into the dynamics of ethnicity in health research, and uphold Māori rights to high quality quantitative data and good analyses. The further demystification of statistical methods can also contribute to the reclamation of Science and Mathematics by the Māori community in general.

A better understanding of the 'behaviour' of ethnicity categorisations in research can help ensure Māori are fully and appropriately represented in health data that informs policy-making and resource allocation in health and ensures the Crown's Treaty obligations to Māori are upheld.

Chapter Two: Ethnicity

The right to health for all, the evidence of persistent ethnic disparities in health and governmental obligation to eliminate these inequalities necessitates monitoring of health events by ethnicity over time. To achieve this, consistent, comprehensive, high quality ethnicity data is required.

Definition of Ethnicity

The word 'ethnicity' is derived from a Greek word meaning people or tribe (Senior & Bhopal, 1994). Definitions of ethnicity in Aotearoa have changed over time from those of blood quantum and ancestry to those of cultural affiliation (Robson & Reid, 2001; Te Rōpū Rangahau Hauora a Eru Pōmare, 2000). There have been (and still are to some extent) blurred lines around the commonly accepted meanings of ethnicity, ancestry, race, citizenship and nationality. This has prompted considerable academic debate and interest.

The description of ethnicity put forward by Statistics New Zealand (2005) (Statistics New Zealand, 2005a) states that ethnicity is:

'the ethnic group or groups that people identify with or feel they belong to. Ethnicity is a measure of cultural affiliation, as opposed to race, ancestry, nationality or citizenship. Ethnicity is self-perceived and people can affiliate with more than one ethnic group'.

- Statistics New Zealand 2005

An ethnic group consists of people who have some or all of the following; a common proper name, elements of common culture such as religion, customs or language, a shared sense of common (geographic) origins or ancestry and a shared sense of destiny, a shared history and a unique community of interests, feelings and actions (McLeod, 2006; Statistics New Zealand, 2005a; Thomas, 2000). Ethnicity, therefore,

is a social construct and acknowledging the different ethnicities in society allows different realities to be captured and recognised.

Culture itself can be defined as a way in which 'human groups create and share explanatory systems about the world in which they live and the ways in which they act according to their shared understandings' (MacDonald, 1999). Culture refers to learned patterns of behaviour and socially acquired traditions and lifestyles, which are distinguished from biologically determined characteristics (Thomas, 2000). In te ao Māori (the Māori world), the word 'tikanga' pertains to culture. The base of this word is 'tika' which means right, correct, straight. Tikanga therefore is the 'correct' way to live, by implication, to live in a way that is accepted by the rest of the social group who adhere to this cultural definition.

The concept of culture is dynamic, and can change and evolve over time in response to changing society, political and environmental influences, and in response to contact with other cultures. Culture is not confined to ethnic groups, but applies also to other groups in society.

Having provided some insight to the definition of ethnicity, a distinction can be made with ancestry, nationality and citizenship. Ancestry refers to genealogical connections to the past. It often has an impact on the choice of ethnic group an individual identifies with, but not necessarily. Genetics and hereditary traits may have relevance when considering ancestry. Nationality can be defined as membership of, or the state of belonging to a particular nation. Citizenship is the status of being a citizen and having membership of a community, or having the rights and duties of a citizen.

These factors can influence a person's ethnic affiliation but do not necessarily determine a person's ethnicity.

Self-identified Ethnicity

It is now generally accepted that ethnicity should be self-identified. Māori and indeed, all persons, have the right to identify for themselves the ethnic group or groups to which they affiliate.

The right of Māori to determine Māori individual and collective identities is endorsed by the United Nations Declaration on the Rights of Indigenous Peoples (United Nations, 2007). For Māori (and other indigenous populations), a history of being re-defined by colonising governments, such as by the use of blood quantum in early governmental definitions of Māori (Te Rōpū Rangahau Hauora a Eru Pōmare, 2000) means that in a modern context, continually asserting the right to self-identification is even more pertinent. Self-identification is a principle of self-determination (Robson & Reid, 2001) and therefore consistent with tino rangatiratanga, Māori pursuit of autonomy.

Ethnicity ascribed to an individual by an observer is influenced by the assumptions and biases of the observer. 'Observer-ascribed', or 'socially-assigned' ethnicity (C. P. Jones et al., 2008) might be influenced by factors such as name, language, residential area and possibly diagnosis of medical condition. Assumptions may be made of an individual based on common stereotypes associated with these factors. Such labelling is susceptible to bias and stigmatisation by the observer who may make value-laden judgements.

The term 'race' usually refers to a way of categorising groups or individuals based mostly on physical appearances, but sometimes on other (largely biological) characteristics. While still commonly used in some countries, the term race has declined in use in New Zealand health research publications since the 1980s (Thomas, 2000) and now is generally not common in New Zealand when referring to ethnicity. Although race is sometimes thought of as a biological construct, it is actually a social construct as it involves labelling of individuals and is subject to the assumptions and ideals present in society.

Self-identified ethnicity has become known as best practice in health research and is considered the most appropriate method for studies on disparities in health and access to health services (Ministry of Health, 2002c; Travassos & Williams, 2007). Unfortunately there are instances in society of an individual's ethnicity being constructed by a third party. This occurs with some frequency when police are searching for a suspect and a physical description is utilised – skin colour and other physical features are often referred to. Ethnicity may also be imposed on an individual by employers, landlords, teachers, doctors and funeral directors (Callister, 2008; Harris, Keefe, Reid, & Robson, 2000).

The issue of who ascribes ethnicity to an individual is not entirely straightforward. For example, if we were assessing the impact of discrimination on health, would self-identified ethnicity fully capture the effects of this discrimination? (Kaplan & Bennet, 2003). Observer-ascribed ethnicity is likely to be based on observers' perceptions of an individual, therefore following the same mechanism as racial prejudice in society (Travassos & Williams, 2007). It has been suggested that even if ethnicity classified by an observer does not match the individual's concept of their ethnicity, it is more likely to match the view of others, and may therefore be more indicative as an explanation for possible unequal treatment (Simon, 2007). These perceived differences can have very real consequences, however the process of racial discrimination is not simplistic (D. R. Williams, 2008).

Camara Jones (2001) describes three levels of racism; institutional or structural, personally mediated and internalised (CP. Jones, 2000). Unequal treatment of an individual in the health system may be the result of any combination of these levels of racism. Personally mediated racism is the most obvious level at which an observer's perceptions of a person can play a part. This is not so immediately apparent with institutional racism which is a result of prejudice so deeply entrenched in society that it is reflected in the structure of health, education, justice and other social services. A person might experience barriers to accessing a service because it doesn't cater for a particular cultural need (Ministry of Health, 2008b). In this instance, the individual's self-identified ethnicity is most relevant (rather than

ethnicity ascribed by an observer) as this will identify the person's cultural values and way of life.

In addition, self-identified ethnicity is most appropriate from a Māori rights perspective. Along with the right to self-identify, Māori have the right to monitor the Crown's action and inaction, (Reid & Robson, 2007) this includes monitoring of progress towards addressing Māori health and inequalities.

There may be a danger of promulgating discrimination and reinforcing stereotypes in society if observer-ascribed ethnicity were elicited in health research or other fields. The view of some researchers is that even the process of dividing people into separate ethnic groups could perpetuate racism, however, it could equally be said that failing to examine health differences by ethnicity in order to address them is racist in itself (Krieger, 2000). In investigating the impact of racism on health, it is necessary to demarcate groups at risk by ethnicity (Krieger, 2010).

In a country with a history of colonisation, the acceptance of a third party deciding an individual's ethnicity could encourage ongoing colonisation, and further promulgate traditional notions of cultural differences and inferiority. However, it has been demonstrated that there is a place in research for 'socially-ascribed' ethnicity. Jones and colleagues found that being classified by others as 'white', regardless of how one self-identifies, is associated with statistically significant health status advantages (Camara Jones, Truman, & Elam-Evans, 2008). This finding provides an indication of how society differentially treats people of different ethnicities.

In some instances, particularly when determining the impacts of racism, self-reported, observer-ascribed ethnicity may be a useful variable to collect. However, in general data collection overall there is a stronger case for self-identified ethnicity. From a Kaupapa Māori stance, ethnicity *must be* self-identified (L. Smith, 1999a). Māori have the right to determine how they wish to be represented, as individuals and as an ethnic group. Self definition better aligns with Māori social reality and is a principle of self determination (Robson & Reid, 2001). To decide another person's

identity is ethically wrong and should be actively discouraged. Put simply, 'people are who they say they are' (Jay S Kaufman, 1999).

Multiple-ethnic Identification and Ethnic Mobility

A person may identify with more than one ethnic group. In the New Zealand censuses from 1991-2006, it was found that multi-ethnic identification was especially pronounced among younger people and among Māori and Pacific peoples of all ages (Kukutai & Callister, 2009). Overall the number of people reporting more than one ethnicity has increased – from 5% of total New Zealanders in 1991 to over 10% in 2006.

Conscious changes may involve an individual changing from one ethnicity to another, or the addition or subtraction of an ethnic group or groups (Carter, Hayward, Blakely, & Shaw, 2009). An individual's choice of ethnicity may be influenced by a range of factors which Tahu Kukutai (2009) categorises as either; structural, personal or contextual (Kukutai, 2009). Structural influences could include the ethnic composition of the neighbourhood, or current political issues that have impact on ethnicity issues. Personal factors could include the strength of the ties that link individuals and their families. Contextual factors refer to the situation in which the ethnicity data is collected, for example; the mode of collection, the reason or perceived reason for data collection, where and by whom the ethnicity information was elicited, what a person perceives as relevant in a situation, or could reflect how comfortable a person feels in that situation. An individual's ethnic identity is influenced by their own perceptions of the meaning of ethnicity, what they perceive as other's views of ethnicity, or others' views of themselves (Carter et al., 2009).

Ethnic mobility refers to a change in an individual's ethnic affiliation. Changes may be 'artificial' – a result of measurement error or a change in the structure of the ethnicity question (Simpson & Akinwale, 2007) – or they may be conscious. It is also possible that changes in ethnicity due to contextual factors (conscious or not) could appear to be ethnic mobility. In a recent study that uses repeated measures to

assess ethnicity over three time periods, it was found that conscious changes of ethnicity were most likely to be made by Māori, younger respondents, those born overseas, those living in a family with children, those in more deprived groups, and those with poorer self-rated health (Carter et al., 2009). The level of ethnic mobility in this study, however, was only moderate with few major ethnic group changes. For the total sample population the proportion of respondents who reported more than one ethnicity was 5.6% at the beginning of the study, which declined to 4.9% by wave three of the study. Ethnic mobility may be the result of 'ethnic shuffling' where an individual keeps one ethnicity and adds or subtracts others, (Callister, Galtry, & Didham, 2009) or people completely changing their ethnic responses over time (Carter et al., 2009).

There are a number of reasons for changes in how an individual identifies. These could include; an individual's own journey of self discovery, changes in personal, professional or social groups, (Carter et al., 2009) exposure to social stigmatisation or alienation, or perhaps exposure to increased acceptance and acknowledgement of different ethnic groups and changes in the political or economic society.

Ethnicity and Genetics

Ethnic differences in health are often (erroneously) assumed to be genetic (Neil Pearce, Foliaki, Sporle, & Cunningham, 2004). Variations in biological characteristics, such as skin colour and facial features, do not consistently distinguish groups of people – genotype does not determine phenotype – and these distinctions are therefore scientifically invalid (Neil Pearce et al., 2004; Thomas, 2000). It has been determined that more genetic variation exists *within* socially defined ethnic groups than *between* groups. Therefore ethnicity cannot be a marker for hereditary traits and vice versa (Braun, 2002; Buchard et al., 2003; Kaplan & Bennet, 2003; Travassos & Williams, 2007). If ethnic groups do not represent distinct gene pools, then genetic explanations for health cannot generally apply. Genes are only one component of the intricate biology of an individual, an individual

who has a complex relationship with their physical and social environment that in turn impacts upon their wellbeing in a myriad different ways (Frank, 2007).

Social explanations for ethnic variations in health are more informative and useful. These can include access to the health system and access to the wider determinants of health, income level, formal education, employment, standard of housing and experiences of racism in the health system and in society. These systematic factors are more amenable to change in the public health arena than genetic factors. Research is intended to contribute to the pool of knowledge and influence decision-making at a systematic level that affects health care, determinants of health and determinants of equity, in a way that contributes to effecting positive change in the health and wellbeing of the population. It is therefore of more use that population groups are socially defined so they are more readily identifiable for targeted policy interventions. To attribute disparities to genetic factors may also evade acknowledgement of social responsibility.

In summary, ethnicity should be self-identified. An individual may choose to identify with more than one ethnic group, and may change their choices over time and in different contexts. Differences between ethnic groups should not be assumed as genetic, rather evidence of socially and culturally distinct groups of individuals.

Measurement of Ethnicity

By its very nature, ethnicity is difficult to measure. The need to allow for self-identification, ethnic mobility and selection of multiple ethnic groups, the change in social perception of ethnicity over time, the varying modes by which the data is collected, the differing information systems used to collate and organise the data, the variety of methods by which the ethnicity information can be aggregated, and the need to capture and acknowledge the country's diversity, all present considerable challenges in any attempt to determine the ethnic composition of a population and undertake health research by ethnic group.

In the past, studies in health research have assumed ethnicity to be simplistic, that ethnicity is fixed over time, that ethnic boundaries are well defined, and that study participants can be readily measured to one discreet category or the other (Carter et al., 2009). Sometimes the criteria used to make ethnic categorisations varies in different studies, (Braun, 2002; Buchard et al., 2003) or is not detailed at all, (Thomas, 2000) effectively making the ethnic categories meaningless, and limiting cross-study comparisons.

There has been some concern that measures of ethnicity are ambiguous and vague and that the unreliability of the data generated could negate its usefulness. Some query whether ethnicity based medicine is useful or problematic (J S Kaufman & Cooper, 2002) and there was even a call in the US to eliminate ethnic classification altogether (Buchard et al., 2003; Travassos & Williams, 2007). The fluid nature of ethnicity does not invalidate it as an epidemiological parameter. Other commonly measured factors are not static, and are susceptible to change over time such as socio-economic status, body mass index or education. Furthermore, factors such as diet, exercise habits, alcohol intake and smoking status are not only likely to change over the course of an individual's lifetime, but the 'accuracy' of such data gathered may also be affected by a whole host of biases. Most, if not all, data used in health research are subject to measurement error, data entry error, limitations of data systems, and even limitations of epidemiological methods to compute and adequately represent the original data in a fashion that is meaningful and useful.

In Aotearoa, recommendations on the production and use of ethnicity data are made by Statistics New Zealand (SNZ) (Statistics New Zealand, 2005a). There has been a concerted effort in recent years to improve the quality and production of ethnicity data, with the recognition of ethnic disparities in health and a commitment from the health sector to reduce these inequities (Ministry of Health, 2002c, 2007). In the health sector, ethnicity data protocols and associated training packages have been produced with the aim to standardise collection and management of ethnicity data (Ministry of Health, 2004a). The ethnicity data protocols recommend that ethnicity is

self-identified, specify the format of the question to be used, and provide protocols on how to record and output data on ethnicity.

Most recently a SNZ review was undertaken in 2004 of the measurement of ethnicity (Statistics New Zealand, 2004) resulting in the Statistical Standard for Ethnicity 2005 which was used in 2006 census outputs (Statistics New Zealand, 2005a). There were some changes made to the Standard Classification of Ethnicity following this review. There are four levels of classification from least to most detailed. Level one (least detailed) comprises six categories plus one 'residual' category ('not elsewhere included'). The six categories used in data output are:

- European
- Māori
- Pacific peoples
- Asian
- Middle Eastern / Latin American / African
- other ethnicity

New Zealand's approach to monitoring health inequities in New Zealand has been recently commended in a report by the World Health Organisation: *Closing the gap in a generation: health equity through action on the social determinants of health. Final report on the social determinants of health* (p115) (Commission on Social Determinants of Health, 2008). Special mention was made of the emphasis on ethnicity recording, matching of census and mortality records, the widespread use of the New Zealand Deprivation Index, and the contribution of these measures to increased cross-sectoral interest in the root causes of inequities. While it is encouraging that these measures are worthy of international note, ongoing work is required to continually improve the measurement and quality of ethnicity data. Over the years, health datasets have consistently undercounted Māori. A project has recently been undertaken to detail the issues in monitoring Māori health and ethnic disparities (Cormack & Harris, 2009).

There is no denying that ethnic disparities in health exist. Disparities reflect an imbalance of power and access in our society and are unfair and unjust (Woodward & Kawachi, 2000). Therefore the measurement and monitoring of ethnic differences in health are of utmost importance. To forego the measurement of ethnicity altogether would prohibit the identification and investigation of the reasons for ethnic differences in health.

Governments have an obligation to pursue equity in health, and epidemiological data informs governmental decision-making. This places an onus on health researchers to overcome limitations of epidemiological measurement tools. Rather than oversimplify the measurement of ethnicity, or worse still, avoid it altogether, there is a challenge to develop methods that can accommodate the complexities of ethnic identification and produce meaningful data that is reflective of a variety of realities. This is one area of epidemiology that may warrant a fresh methodological approach. Kaupapa Māori epidemiology could provide this philosophical basis. Having at its core the right to self-determination, this entails the right for Māori and other indigenous populations to self-identify, to decide how Māori are best enumerated and represented in health data, to critique existing epidemiological methods, to explore modification of statistical tools, or develop new methods in the pursuit of equity and ultimately, the pursuit of health improvement.

Therefore, there is a strong imperative for quality ethnicity data. Past official health data have been shown to undercount Māori. Calculation of rates of disease, for example, are used to determine disparities in health outcomes between Māori and non-Māori, and therefore inform decision making on policy direction and resource allocation. Undercount of Māori has been most commonly demonstrated in frequently used numerator data in the calculation of rates. Also different approaches have been used resulting in systematic differences in ethnicity recording in numerator sources (such as cancer registrations, hospitalisations and deaths) and denominator sources (such as the census). The differential undercounts in denominator and numerator can lead to a mismatch in the data or 'numerator-denominator bias'. Usually resulting in an underestimate of rates of adverse health outcomes among Māori.

Numerator-denominator Bias

When numerator data originates from a different source to denominator data, a differential bias can result if the completeness or quality of data is different in each source. For example, ethnicity might be determined in a different manner when numerator data is gathered (for example, on a questionnaire during hospital admission) compared to the manner in which denominator data is gathered (for example, census question). The inconsistency of ethnicity information collection therefore creates a differential bias between numerator and denominator.

Census information provides denominator data for calculation of most population rates, and is considered a relatively comprehensive source of ethnicity data, with approximately 98% coverage of the population of New Zealand,[iii] and allowing for ethnicity to be self-identified. Population estimates generated by Statistics NZ adjust for undercount of Māori.

The undercount of Māori is likely to be greater in numerator data than in denominator (census) data. As mentioned earlier mortality data during the 1991-1994 period underestimated Māori deaths by 25%. Using this mortality data in the calculation of population mortality rates therefore led to major underestimation of the rate of death for Māori during this time period.

Undercount, bias and methods to improve estimates of Māori will be discussed in the next section. Initially, however, further detail is required on measurement of ethnicity, and related issues. The following section therefore will detail sources of ethnicity data particularly relevant to this dissertation, the different methods currently used to measure ethnicity in health research, data measurement issues to consider for each source, and methods developed in order to improve Māori health estimates.

[iii] A post-enumeration survey run shortly after the census estimated that the census counted 98.4% of the NZ population in 1996, 97.8% in 2001 and 98.0% in 2006. http://www.stats.govt.nz/Publications/PopulationStatistics/frequently-asked-questions-population-statistics accessed 12 January 2010

Sources of Numerator Data in Health Research

There are various sources of routinely collected data that provide numerators in the calculation of rates, or can be used to define a cohort in cohort studies. Those most relevant to this dissertation will be detailed in this section, including the methods of collection, data management and maintenance, the strengths and limitations of each method and quality of data for Māori.

National Health Index

The National Health Index (NHI) number is the unique identifier assigned to each person using health and disability services. Coverage is estimated to be 98% of the population. The NHI number identifies an individual for referrals, hospital visits, tests and patient-related correspondence and is used to uniquely identify health and disability support information in national clinical databases such as the Medical Warnings System and the National Immunisation Register. The National Health Index is an index of information associated with that unique number, and was instigated in 1993, replacing the National Master Patient Index, which was itself implemented in 1977. Newborn babies have been registered on the national system since 1992.

Information held on the NHI includes: name, NHI number, address, date of birth, sex, New Zealand resident status, up to three fields for ethnicity, date of death, and flags indicating any medical warnings or donor information. Clinical information is not held on the NHI.

The Ministry of Health uses an encrypted form of the NHI number to uniquely identify health and disability support events on statistical databases enabling data from different sources to be linked while still protecting the privacy of individuals. The NHI database is maintained by the Information Directorate of the Ministry of Health (formerly known as New Zealand Health Information System (NZHIS) prior to mid 2008). An individual's details are updated with each new data entry. Therefore,

ethnicity on an individual's NHI should be that recorded at the most recent health event such as a hospitalisation.

Assuming ethnicity data has been correctly gathered from an individual and entered into the system as per the ethnicity data protocols for the health sector (Ministry of Health, 2004a), ethnicity on the NHI would be that which a person currently self identifies with, therefore allowing for any change over time in the way a person chooses to identify. With the recent NHI Upgrade Programme, additional data elements added included ethnicity history.[iv]

Ethnicity recorded on an individual's NHI number is therefore as current as their most recent health event, providing this data has been updated. One of the methods that this dissertation will use to measure ethnicity in this cohort is that recorded on an individual's NHI number as at the date of data extraction.

There is some evidence of possible undercount of Māori on the NHI. Fawcett and colleagues reported that the NHI tends to underestimate total and prioritised ethnicity counts for Māori, Pacific and Asian ethnic groups when compared to the census (Fawcett, Atkinson, Herd, & Blakely, 2008). The census to NHI ratio for Māori for both prioritised and total ethnicity was 1.13, indicating that the NHI data undercounts Māori and to obtain a more accurate estimate of Māori from the total NHI database, data needs to be adjusted by a factor of 0.13.

National Minimum Dataset

The National Minimum Dataset (NMDS) is a national collection of public and private hospital discharge information, including clinical information for both inpatients and day patients. All records have a valid NHI number. The NMDS was implemented in 1993 and back-loaded with public hospital discharge information from 1988. The

[iv] www.nzhis.govt.nz/moh.nsf/pagesns/269?Open accessed 2 June 2009. Ethnicity history refers to how an individual's ethnicity has been recorded previously on the National Health Index

current version of the NMDS was introduced in 1999. Data has been submitted electronically by public hospitals since 1993, and private hospital data for publicly funded events such as birth events and geriatric care, has been collected since 1997. Publicly funded hospital events are required to be loaded into the NMDS within 21 days after the month of discharge. Surgical events from some private hospitals are up to date, however data entry of privately funded hospital events may be delayed.

Data from hospital records constitute one of the few datasets available to describe morbidity in New Zealand, and as such provides an important source of information on the health status of the population. Ethnicity data should be collected with each hospitalisation for an individual, ideally using a standardised question (the census question) and allowing for self-identification. Up to three ethnicity fields can be entered into the system. The ethnicity recorded with each hospitalisation event can be determined for an individual from the NMDS. Event ethnicity is additional to NHI ethnicity.

There is evidence of undercount of Māori in hospital discharge data (Harris, Purdie et al., 2007; Harris, Robson, Reid, & Keefe, 1997; Ministry of Health, 2010; Swan, Lillis, & Simmons, 2006). Accuracy of ethnicity data on the NMDS depends on standardisation of the data collection at the time of hospitalisation, the ability of an individual to self-identify (the nature of the injury or illness deems it sometimes necessary for next of kin to complete this information) and any error on data entry. Sometimes data may be omitted, or may even be ascribed by a hospital staff member, therefore not allowing for self-identification. Data may also be miscoded on entry into the hospital database, or the database may not have the appropriate level of codes (for example, only a minimum of Level 2) for input or output.

Over time, there appears to have been improvements the level of undercount. Studies in the 1990s showed a 20-25% net undercount of Māori in hospitalisation data (Harris et al., 1997; Robson et al., 1996). However more recent estimations showed hospital data required adjustment by 5-15% and cancer registration data

between 2-15% (Harris, Purdie et al., 2007). While these findings suggest an improvement in the quality of ethnicity data, undercount of Māori persists.

Staff training and education is vital for understanding the importance of collecting accurate, self-identified ethnicity. This could vary across hospitals leading to a variation in practices. It is also likely to have changed over time as improved protocols are introduced (Robson et al., 1996).

Mortality Collection

Originally, mortality data was contained in the NMDS, however it has been removed as a subset and now held in a separate collection. Deaths registered from 1988 onwards are held on the NZHIS Mortality Collection database. Earlier death data to 1970 is available by special request. The Mortality Collection classifies the underlying cause of death for all deaths registered in New Zealand, including all registered fetal deaths (stillbirths), using the ICD-10-AM 2nd Edition and the World Health Organisation rules and Guidelines for Mortality Coding.[v] Data from Births, Deaths, and Marriages (BDM) is updated monthly.

Currently, the ethnicity of a deceased person is entered onto the notification of death certificate by the funeral director in consultation with the family, and should utilise the standard ethnicity question. Ethnicity is then coded by NZHIS using the Statistics NZ (level 2) classification. Up to ten ethnicities can be provided. During the loading process, these are automatically prioritised and only three ethnicities are stored (New Zealand Health Information Service, 2004b). There is also a separate Māori descent indicator based on the question: 'was the deceased descended from a New Zealand Māori?' yes/no/don't know (N Pearce & A, 2004).

In this study, mortality data will be used in two instances, as a source of data to assign ethnicity to an individual by the ever Māori method (this method will be

[v] www.nzhis.govt.nz/moh.nsf/pagesns/57?Open accessed 28 October 2009

described later in this section), and to produce mortality hazard ratios (risk of death over time).

Data on death registrations has been shown to undercount Māori (Blakely, Salmond, & Woodward, 1999; Graham, Jackson, Beaglehole, & Boer, 1989). In 1995 there was a change to ethnicity recorded on death registration with the new question approximating the self-identified question on the 1996 census (Blakely, Atkinson, & Fawcett, 2008). The number of Māori deaths appeared to increase by 70% between 1994 and 1996, demonstrating a substantial undercount in mortality data prior to 1995 (Harris et al., 2000; Tobias, 2001). The estimated undercount of Māori for 1991-1994 was 25%, indicating that the procedure used to measure ethnicity on death records during this time systematically misclassified Māori. Half of 0-14 year old Māori deaths were not recorded as Māori, and there was variation of undercount by age group and region (Blakely, 2002b). There has since been an improvement in death registration ethnicity data with no net undercount of Māori found in the 2001-04 mortality data (Blakely et al., 2008; Fawcett et al., 2008). This will be detailed later in this section.

Other Sources of Numerator Data

Cancer Registry

Similar to mortality, cancer data was originally held on the NMDS but was removed with the establishment of the New Zealand Cancer Registry (NZCR). Set up in 1948, the NZCR is a population-based register of all primary malignant diseases diagnosed in New Zealand, excluding squamous cell and basal cell skin cancers. Since the introduction of the Cancer Registry Act 1993 and the Cancer Registry Regulations 1994, there has been a significant improvement in ethnicity data quality and completeness, and the NZHIS is currently working with clinicians to improve the staging information.[vi]

[vi] http://www.nzhis.govt.nz/moh.nsf/pagesns/64 accessed 28 October 2009

Laboratories are the main source of cancer data for the NZCR, with additional data coming from Medical Certificates of Causes of Death, Coroners' findings, and public and private hospital discharge data. Ethnicity for the NZCR is mostly taken from records obtained from hospital encounters (Shaw, Atkinson, & Blakely, 2009). Electronically received data is updated monthly from the NMDS, with hard copy information entered manually on an ongoing basis. It has been shown that Māori are undercounted in cancer registry (Robson, Purdie, & Cormack, in press; Shaw, Atkinson, & Blakely, 2009).

The method used to assign ethnicity to cancer registrations has recently changed. Since 2009, ethnicity is now assigned to cancer registrations by looking at the ethnicity recorded in each of the corresponding death registrations, hospitalisation records and on the NHI. Following this, a cancer registration is automatically assigned the ethnicity(s) on the death registration (where applicable) and the NHI (unless not stated or 'other' on the NHI). In addition to this, if an ethnicity is recorded on at least 20 percent of an individual's hospitalisation records, this ethnicity is assigned to the cancer registration. Therefore, when there are different ethnic groups on the different source datasets, multiple ethnicities are recorded on the cancer register (Ministry of Health, 2010).

However, it has been found that when cancer registrations were linked to death registrations and Housing New Zealand Corporation tenant data, there still appeared to be an undercount of Māori cancer registrations (which varied by deprivation and rural-urban status). For the completion of the recent publication *Unequal Impact: Māori and non-Māori Cancer Statistics by Deprivation and Rural-Urban Status 2002-2006* by Robson and colleagues (in press), adjusters were created for cancers registered between 2002-2006 to adjust for the residual undercount of Māori registrations. These adjusters increased the total number of Māori cancer registrations by approximately 10% (Robson et al., in press).

Maternal and Newborn Information System, Mental Health Information National Collection and Primary Care Data

Other sources of routinely collected national health datasets include; the Maternal and Newborn Information System (MNIS), the Mental Health Information National Collection (MHINC) and Primary Care Data. These will not be discussed further in this dissertation.

Sources of Denominator Data in Health Research

Census

Dependent on the nature of the study, routinely collected data can provide both numerators and denominators, such as in a cohort study. However, the most common source of denominator data used in determining rates of morbidity and mortality by ethnicity is provided by New Zealand's 5-yearly national Census of Population and Dwellings. Statistics New Zealand is responsible for administering the census and collating and distributing resulting information. The census is an official 'count' of every person in the country on a given night and provides an important snapshot of demographic factors such as the age of the population, employment, education, family composition and so on. Trends over time are also determined from consecutive censuses.

As the 5-yearly census is a key source of denominator data, any change to the collection of information on the census can have a profound impact on population rates and the ability to monitor health trends over time. In Aotearoa, changes to the ethnicity data question in the recent past have altered representation of ethnic group denominator data (Te Rōpū Rangahau Hauora a Eru Pōmare, 2000).

Ethnicity in Aotearoa has moved from a biological, descent based approach to one of cultural affiliation over time. In 1981, respondents were asked their 'ethnic origin' with options to 'tick box which applies' if 'full Māori, full European or full Caucasian'

and so on. Blood quantum was required if the respondent was not 'full' anything. This changed somewhat in 1986 to asking respondents 'what is your ethnic origin?' and to 'tick box or boxes which apply to you', therefore allowing for multiple ethnicities to be identified and no blood quantum required. In the 1991 census there was a further change – a separate question on Māori ancestry was included, the option to select more than one ethnic group was provided and the question related more to cultural affiliation than origin – 'which ethnic group do you belong to?' (Thomas, 2000).

The change to multiple ethnic group options produced potentially different Māori populations; those that identified as Māori only ('sole Māori') and those that identified as Māori plus one or more other ethnic groups ('mixed Māori'). The 'Māori ethnic group comprises those that identify as 'sole Māori' plus those who are 'mixed Māori'. The option to select more than one ethnic group was made available again in the 1996 census, however the different wording to the question appeared to 'encourage' a higher number of people to identify with more than one ethnic group by requesting respondents to 'tick as many circles as you need to show which ethnic group(s) you belong to' (Public Health Intelligence, 2001a; Te Rōpū Rangahau Hauora a Eru Pōmare, 2000). In addition, the question offered more ethnic group options to choose from which also encouraged respondents to identify with more than one group. For example there was a 124% increase in the number of Māori recording multiple ethnicities between the 1991 and 1996 censuses (Statistics New Zealand, 1999). In the 1996 census, 7.56% of the population identified as sole Māori, and 14.5% as Māori ethnic group (Thomas, 2000). The increase in recording of multiple ethnicities occurred not only for Māori, but for all groups and was attributed to the change in format of the question.

These changes in the census ethnicity question disrupted time-series analyses and limited comparisons over time during this period. Unfortunately this was also a period of significant social and economic reform, during which monitoring of disparities by ethnicity was even more pertinent (Te Rōpū Rangahau Hauora a Eru Pōmare, 2000).

The 2001 and 2006 question changed from 1996 and reverted to that used in 1991 with a minor word change. It remained constant for these two censuses. The question was phrased; 'which ethnic group do you belong to? Mark the space or spaces which apply to you'. In addition less ethnic groups were offered in the list to choose from.

These changes in the ethnicity question reflected changes in society around the concept of ethnicity and identity, from one of ancestry to one of belonging and affiliation to a culturally defined ethnic group. As Nancy Krieger (2000) states; 'classifications and categories employed in any census are enmeshed in the social and political realities of the society' (Krieger, 2000). However, these changes also created an inconsistency in denominator data over this time, particularly the 1996 census (Public Health Intelligence, 2001a; Te Rōpū Rangahau Hauora a Eru Pōmare, 2000). Various measures to improve estimates for this time period were proposed including the use of the 'sole Māori' group as denominator for the analysis of disparities in the 1990s in order to maintain consistency of the denominator over time. The sole Māori group was more similar in size to the previous Māori populations based on blood quantum (half or more Māori blood) (Te Rōpū Rangahau Hauora a Eru Pōmare, 2000). It has been shown that 'sole Māori' experienced poorer health than the 'Māori ethnic group' population over this time period (Ajwani et al., 2003c). However, it must be remembered that the sole Māori group is a subset of all those who identify as Māori and therefore does not include a substantial group of those identifying as Māori.

Population estimates serve as more accurate denominators (than census counts) for the construction of population-based rates as they take into account; non-response to the census ethnicity question, net census undercount, residents temporarily overseas on census night, births, deaths and net migration between census night and 30 June.

Methods to Improve Māori Health Estimates in Health Data

As mentioned earlier, numbers of Māori in official health data have been underestimated in the past (Ajwani et al., 2003a; Te Rōpū Rangahau Hauora a Eru Pōmare, 2000). The following section will detail some of the methods that have been developed or proposed in order to improve ethnicity estimates on routinely collected datasets. These methods involve either the individual reassignment of ethnicity, as in the 'ever Māori' method, or the development of adjusters to apply to data with known undercount. Adjusters are determined by linking health datasets to datasets with better quality ethnicity in order to quantify the misclassification of ethnicity in the original health datasets. The adjusters are calculated and then applied to aggregate health data. Adjusters have been calculated for mortality data (Ajwani et al., 2004; Ajwani et al., 2003a; Ajwani et al., 2003b; Blakely et al., 1999) for cancer registration data (CancerTrends) (Blakely et al., in press; Shaw, Atkinson, & Blakely, 2009; Shaw, Atkinson, Blakely et al., 2009) and for both hospitalisation and cancer registration data (Hauora IV adjusters) (Harris, Purdie et al., 2007).

Methods to Improve Māori Health Estimates - Numerator Data

The New Zealand Census Mortality Study

The New Zealand Census-Mortality Study (NZCMS) is a cohort study that probabilistically and anonymously linked census data and mortality records.[vii] The study enabled estimation of the undercount of Māori in death registrations over several time periods.

This study quantified the misclassification of ethnicity by matching death records to census records for the three-year period following each census, creating five cohorts between 1981 and 2004. The adjusters developed (termed 'unlock ratios') can then

[vii] A description of the methods used in this study can be found in Blakely et al 1999 and Blakely 2002.

be applied to correct for misclassification of ethnicity on mortality data for each of these time periods. The estimation of ethnic specific rates using these adjusters are then free of numerator-denominator bias (Ajwani et al., 2004; Ajwani et al., 2003a).

The NZCMS demonstrated that Māori and Pacific peoples were grossly undercounted on mortality data until the mid-1990s. From 1981–84, 16% more 1–74 year olds had self-identified as 'half or more Māori' on the 1981 census than are recorded on death records, the corresponding value for the time periods 1986–89 and 1991–94 was 32% each. However, when death registrations and census data were probabilistically matched for the four year period 1996-1999, the NZCMS results showed that the undercount on mortality records had decreased to 7% (Ajwani et al., 2004; Ajwani et al., 2003a; Ajwani et al., 2003b). Differences in misclassification of ethnicity for Māori were also revealed by cause of death, age and rurality (Ajwani et al., 2003a).

When the study was extended to cover the subsequent four year period 2001-2004, it was found that while some disagreements in ethnic group coding between mortality and census data still occurred, accuracy was much improved compared to earlier time periods, with no net undercount of Māori. The authors concluded that with use of the 'total' ethnicity on both census and mortality data in the early 2000s, ethnic mortality rates will contain little, if any, numerator-denominator bias (Blakely et al., 2008). The differences by Regional Health Authority using total ethnicity were not as notable as in previous years. However, there were some slight regional differences. In the South island, census-mortality ratios differed with the use of 'total' Māori vs 'sole' Māori, suggesting higher underreporting of multiple ethnic groups on mortality data in this region.

By applying the appropriate unlock ratios, mortality data for the time period 1981-2004 (in particular 1981-1999) can be adjusted to produce more accurate estimates of mortality rates for Māori over time without numerator-denominator bias. As earlier mentioned, the 1990s was a time of major social and economic reform in Aotearoa which disproportionately impacted on Māori (Ministry of Health & University of Otago, 2006e).

However, these ratios cannot be applied to other sources of numerator data such as hospitalisations or cancer registrations, as the ratios are based on mortality only. New Zealand Census Mortality Study mortality adjusters also cannot be applied to individual data. While they are calculated at an individual level by probabilistic matching of records, the results are aggregated and then can only be applied to other external data at aggregated level.

Furthermore, the adjusters developed are retrospective, so more timely estimates of mortality are difficult as the development of the unlock ratios is subject to the availability of census data. Incomplete linkage of datasets contributes some level of error to the ratios, although methods were implemented to limit this bias (Blakely et al., 2008). The calculation of these ratios requires specialist statistical expertise and are therefore resource and time intensive.

Finally, the method is dependent on (and assumes) reliable ethnicity data on the census. It is therefore vulnerable to census ethnicity changes over time.

Development of Adjusters – Hauora IV

Recent statistics on disparities in health between Māori and non-Māori are presented in the publication *Hauora, Māori Standards of Health IV: a study of the years 2000-2005* (Robson & Harris, 2007). It was recognised that hospital discharge and cancer registration data undercounted Māori. To estimate this undercount for the calculation of population rates, data from these sources were linked to datasets with more reliable ethnicity data. These were death registrations for the period 2000-2004 which had been found to have relatively accurate ethnicity data (Blakely et al., 2008) and Housing New Zealand Corporation (HNZC) tenant data 2003-2005 which has been shown to have an overall match rate of 92% to data on NHI database (Baker et al., 2006). In this way, the numbers of Māori hospitalisations or cancer registrations using ethnicity as recorded could be compared to the numbers of Māori using the ethnicity on the linked dataset, derived from either mortality or HNZC records. The

overall difference is then estimated as a ratio and the resulting smoothed adjusters are applied to aggregate data (Harris, Purdie et al., 2007).

It was found that undercount varied by age, showing a lower undercount in younger age groups that increased with age. For this time period, linkage showed that Māori hospital numbers and cancer registrations were underestimated. To produce more appropriate estimations, adjusters should be applied. For hospital registrations the adjusters were calculated to be between 5 and 15%, and for cancer registrations between 2 and 15%, depending on age.

This undercount creates a numerator-denominator bias when rates are calculated using population census data as denominators. Adjusters were therefore developed in order to minimise this bias. To do this, a weighted average of the HNZC linkage and mortality linkage ratios in five-year age groups was calculated. The ratios were then smoothed to create adjusters (Harris, Purdie et al., 2007) which were consequently applied to numerator data for Māori (hospitalisations and cancer registrations). Non-Māori numbers were calculated as the difference between the total number and the adjusted Māori numbers. These values for Māori and non-Māori were then used as numerators in the calculation of population rates and ratios in *Hauora IV*.

As the adjusters are age-specific (5-year age groups), this also allows the calculation of more accurate age-specific and age-standardised rates. A further strength of this method is that in minimising numerator-denominator bias, a better comparison of rates and ratios across hospital, cancer and mortality data sets is enabled (Harris, Purdie et al., 2007).

These adjusters have been developed over a specific time period of data, (2003-2005 for hospitalisation data, 2000-2004 for cancer data) and it cannot be assumed that they can be applied to either earlier or later time periods, particularly as it has been shown that quality of ethnicity data has changed over time (Blakely et al., 2008; Shaw, Atkinson, & Blakely, 2009).

The adjusters were calculated with national-level data, and may not necessarily directly apply to the regional level. Ethnicity data quality has been shown to vary by region (Blakely, 2002a). Similarly, adjusters cannot be applied at an individual level, so are therefore unable to be used in a cohort study.

Ever Māori Classification

The 'ever Māori' method counts as Māori anyone ever recorded as Māori, either sole or total, in any cancer registration, hospital admission or death registration, or on the National Health Index. Individuals on datasets from the different sources are linked using an encrypted unique National Health Index number. Therefore, where individuals with multiple events were 'ever' recorded as Māori, the ethnicity for all records for that individual are individually reassigned as Māori for the purpose of the study only. All remaining records are classified as non-Māori, and this usually includes those that have no ethnicity specified. This method of classification is normally conducted over a specific time period for a study.

The 'ever Māori' method of assigning ethnicity has been used in various studies to adjust for undercounting of Māori in health data sets (Cormack, Robson, Purdie, Ratima, & Brown, 2005; Curtis E, 2005; Harris, Robson et al., 2007; Ministry of Health, 2006a; Robson et al., 2006).

There are considerations to be made when using this method of classification. The major assumption is that Māori are undercounted in health data sets. However, it has been hypothesised that this method may correct undercount for older age groups better than for younger age groups. Both morbidity and mortality are closely associated with age. Older patients are more likely to have had a greater number of admissions, therefore an increased likelihood of being classified as Māori (Curtis E, 2005).

A longer time period over which ever Māori is determined in a study would possibly produce an overcount, as this increases the likelihood of more hospitalisations for an individual, and therefore a greater chance of false positives. A false positive refers

to when a person is recorded as Māori when they are not. The chance of this occurring increases with an increased number of events, which increases with more years of data. In addition, over a longer time period there may be improvements in ethnicity data collection and completeness, therefore potentially minimising the undercount of Māori. This could also lead to an overcount with the use of ever Māori.

In analyses of earlier periods (1996-2001) the ever Māori method appeared to produce reasonable estimates of deaths and cancers (Curtis E, 2005; Robson et al., 2006). However, it seems to result in an overcount of Māori in recent years of analysis for deaths and cancer registrations from 2000-2004 and hospital discharges 2003-2005 (Harris, Purdie et al., 2007). It has been suggested that this may be due to the use of additional years of data, and/or to improvements in ethnicity recording on death registrations.

While the 'ever Māori' method upholds the right to be counted for Māori, it does not allow for ethnic mobility. As indicated earlier, an individual's ethnicity can change over time, ethnicity is dynamic and a person has the right to change their nominated ethnicity. The ever Māori method will count an individual as Māori if they have ever identified as Māori regardless of whether they have intentionally subsequently changed the ethnicity they wish to self identify as at some point. Of course, in most datasets it is not known whether a person has deliberately changed their ethnicity, or if the change is due to other reasons including administrative error or poor data collection.

Despite these considerations, the 'ever Māori' classification of ethnicity is able to be applied in a cohort study as it involves the individual assignment of ethnicity.

CancerTrends

Recent work has been undertaken to link census and cancer registry data in order to quantify undercount of Māori and Pacific peoples in cancer incidence statistics. The extent of misclassification between 1981 and 2004 (in five 5-year cohorts) has been

estimated, and can be presented using any ethnicity output for Māori and Pacific peoples (Blakely et al., in press; Shaw, Atkinson, Blakely et al., 2009). The recently published study by Caroline Shaw and colleagues presented results using total ethnicity output. For all cancers it was found that the extent of undercount for Māori was as much as 31% in the 1981-1986 cohort, but decreased over time to produce an undercount of 15% in the more recent 2001-2004 cohort. This is a slightly higher undercount of Māori than that calculated for *Hauora IV*.

The data showed that while there have been improvements over time in the accuracy of ethnicity data on the New Zealand Cancer Registry, undercount of Māori (as well as Pacific and Asian ethnic groups) persists.

The study produced adjustment ratios for total cancers, and for common cancer sites that can be used to ascertain corrected population estimates for incident cancer by ethnicity for this time period (Shaw, Atkinson, & Blakely, 2009). Similar to NZCMS unlock ratios, and adjusters for *Hauora IV,* these adjustment ratios can only be applied at an aggregate level such as in the production of population rates.

Methods to Improve Māori Health Estimates – Denominator Data

Use of NHI Data as Denominator

In order to reduce misclassification and eliminate numerator-denominator bias caused by differing degrees of accuracy of ethnicity data in the numerator and denominator, Shaw et al have recently suggested that the NHI file could potentially be used as the denominator in the calculation of rates rather than census data (Shaw, Atkinson, & Blakely, 2009). This could apply for non-cancer, and non-mortality events such as hospitalisations or surgical procedures.

Therefore all datasets which can be linked to, or have data on, ethnicity from the NHI could be used as sources of numerator data (such as the NMDS), and analyses would be possible by several demographic factors in addition to ethnicity such as

sex, age, deprivation and region. However, if the NHI is the only source of data in the calculation of rates, the undercount will be the same in the numerator and denominator and the rates will be relatively unbiased. While this would be an improvement compared to the use of an external denominator (as numerator-denominator bias is eliminated), this method still depends on the quality of ethnicity data on the NHI overall, and would not be a likely option if there is, or becomes, considerable undercount of Māori in this dataset.

There are further limitations to this proposal. Calculation of accurate historical rates will not be possible as the NHI file is constantly updated; actual numbers of events by ethnic group will still be biased when compared to census ethnicity; and finally, the NHI file is likely to include many who have migrated out of New Zealand, whereas this information can be determined from census data. The NHI is estimated to have 98% coverage of the population however there are also instances of 'duplicates' where an individual has been assigned two NHI numbers. A 12-month duplicate resolution programme identified 125,000 duplicates. The identification of duplicate NHI numbers is an ongoing task.[viii]

Adjusting Census Data for use as Denominator

The census differentially undercounts Māori, males and young adults compared to other groups, also Māori living in the most deprived deciles are more likely to be undercounted than Māori living in less deprived areas. For the calculation of recent cancer statistics for the period 2002-2006, new deprivation and rural-urban denominators were constructed for incidence and mortality analyses by deprivation and rurality, by adjusting population estimates obtained from Statistics New Zealand (Robson et al., in press).

[viii] http://www.nzhis.govt.nz/moh.nsf/pagesns/270?Open Accessed 12 January 2010

Ethnicity data Input and Output

A distinction is made between ethnicity data 'input' – the collection of ethnicity data from individuals, (allowing for self-identification) and 'output' where identification decisions can be tabulated and analysed.

Multi-ethnic Identification

New Zealand is one of the few nations that allows for identification with multiple ethnic groups on census and health information. Since the ethnic group question was introduced in the 1986 census an increasing proportion of the New Zealand population has reported belonging to more than one ethnic group. Multi-ethnic identification has been greater amongst younger people and Māori, Pacific and Asian peoples (Carter et al., 2009; Kukutai & Callister, 2009). In the recent 2006 NZ Census, 7.8% of total respondents aged 15 years and older identified with multiple ethnic groups (Statistics New Zealand, 2006b). Statistics New Zealand can code up to 239 ethnicities, but records only six different responses out of these possible 239 different codes. If a person indicates more than 6 ethnicities in the census, for example, a randomisation process is used to determine which six will be coded. In this case, their ethnicities are first aggregated into broader groups where possible, for example if a person identifies as British and Scottish (among others), these will be aggregated as European. Many health data systems can often only record up to three ethnicities for an individual.

Prioritisation

In prioritised ethnicity output, Māori have priority coding, followed by Pacific peoples, Asian, other ethnic groups besides European, 'other' European and then New Zealand European (Allan, 2001). An individual who self-identifies as Māori and Samoan, for example, would be classified as Māori using this method.

This has a methodological advantage in that standard statistical techniques are readily applied, as they often require mutually exclusive categories. Also this

method does not create a total greater than the total number of individuals in a study, as each individual is allocated to just *one* ethnic group. The sum of the ethnic populations adds up to the total population in a study. It may also have the advantage of having conceptual simplicity – some data users may feel more 'comfortable' when people are placed in seemingly clear-cut groups (Kukutai & Callister, 2009).

Prioritisation can help ensure ethnic groups of policy importance, such as those that experience poorer health, or ethnic groups of small size numerically, are not 'swamped' by the numerically dominant group. This was one of the reasons for the development of the method as noted by in the 1993 New Zealand Standard Classification of Ethnicity (Department of Statistics, 1993).

Prioritisation is, in part, consistent with Kaupapa Māori theory. It ensures that the Māori ethnic group in any study is inclusive of *all* those who identify as Māori. However, it doesn't allow for multiple ethnicities to be acknowledged within a study, as just one ethnicity is allocated per person.

Prioritisation also reduces the count of some other ethnic groups, particularly Pacific peoples. This issue of undercounting may be less of a concern in the calculation of rates as the method of output is applied to both numerator and denominator. It has been found in a study undertaken by Public Health Intelligence (PHI) that little difference was made to rates in terms of both absolute and relative differences (Ministry of Health, 2008a).

Prioritised ethnicity output has been utilised in health (and other) research for several years, however the 2005 Ethnicity Standard recommended its use be discontinued and 'total response' or 'single/combination' response be used, with the use of 'randomisation' as a method to reduce the number of responses where necessary (Statistics New Zealand, 2005a).

This dissertation uses prioritised ethnicity output. While the weaknesses of this method are acknowledged as outlined above, compared to other forms of output,

prioritised ethnicity is most consistent with Kaupapa Māori theory. Māori numbers are less likely to be overwhelmed by data for other numerically dominant ethnic groups, and it allows for all those who have ever been identified as Māori to be counted as Māori as health data has been shown to undercount Māori. In this way, Māori remain centralised as much as possible while retaining the integrity of the quantitative data. There is the added statistical advantage in that the sum of the ethnic populations adds up to the total population in a study and therefore epidemiological methods can be readily applied.

Total Response

In this method of outputting ethnicity data, an individual is counted in each of the ethnic groups that they have reported allowing for acknowledgement of *all* the ethnic groups a person identifies with.

The sum of the ethnic group populations will therefore exceed the total population of respondents in a sample. There are limitations to using total response output. The recent change to recommendations from prioritised output to total interrupts health time series trend analysis over this period. The use of total counts limits comparisons with earlier data generated using prioritised ethnicity output, or may require additional statistical work on the data to enable valid comparisons to be made. Total ethnicity also creates overlapping ethnic groups, as a person is counted more than once (if they have selected to identify with more than one ethnicity) and therefore their health is reflected in the data for more than one group. This may also have the effect of minimising the appearance of disparities, as the groups are more similar with regards to health status.

Single/Combination

This method, also recommended as an option by Statistics New Zealand, counts individuals once in aggregate single or combination groups. In this form of output, there are sole ethnic categories for respondents who report only one ethnic group, and ‘combination’ categories for those who report more than one. This method

essentially creates a number of 'blended' categories with combinations such as Māori/NZ European, Māori/Samoan, Samoan/Tongan and so on.

The standard single/combination minimum categories are:

- European
- Māori
- Pacific Peoples
- Asian
- Other
- Māori/European
- Māori/Pacific peoples
- 'two groups not elsewhere identified'
- 'three groups' (Statistics New Zealand, 2004)

It is argued that this categorisation does not change the responses that people originally indicate, and reflects the diversity of the population. However, it assumes that individuals identify equally with each of the groups they indicate, or that the blended categories reflect a distinct social group in themselves.

Furthermore, the combinations do not include all possible combinations of ethnicities. Even with the minimum categories, representation of data in a study using this method can potentially be quite large and complex, producing practical difficulties.

Māori are most likely to record multiple ethnicities, (Kukutai & Callister, 2009) and numbers of Māori are therefore most likely to be affected by this method, reducing the number of Māori in the 'single Māori' category.

Input Randomisation

In some cases the number of responses to the ethnicity question recorded by an individual is greater than the system can cater for. The revised 2005 Statistical Standard recommends that where more responses are given than can be recorded

per person, a random method for reducing the number of responses 'selects' the ethnicities to be retained (Statistics New Zealand, 2005a). This method is designed to retain Level One data where possible.

Previous to 2005, Statistics New Zealand recommended prioritisation on input. In the 2006 census and some other current official surveys, up to 6 responses are able to be recorded for an individual. In previous censuses, a maximum of 3 ethnicities were recorded.

Input randomisation is particularly an issue if responses are being reduced to a low number such as three. It is then possible that groups of policy interest such as Māori or Pacific are not included in the three selected responses for individuals who have selected more than three responses. In addition, an individual's responses (when more than three are selected) may be randomised differently on different data sources (Cormack & Harris, 2009).

At an operational level there may also be the risk of discretionary decisions being made about which ethnicities to input if the process of randomisation is not commonly used or understood (Cormack & Harris, 2009). This potential lack of consistency may limit comparability of datasets.

In health, this is an area where there is inconsistent policy. While Statistics New Zealand recommends input randomisation, the Health data protocols still stand which recommend prioritisation. This is likely to lead to different methods being used with health data, potentially impacting on comparability across different studies, and over time.

Self-prioritisation

The allowance for multi-ethnic identification on the census and other data sources provides a challenge for data output. How should individuals that identify with more than one ethnic group best be represented? Does the individual identify equally with

each ethnic group? Are the ethnic groups viewed separately or as 'blended' ethnicities?

A system of self-prioritisation has been suggested (Kukutai & Callister, 2009). Individuals are provided with the option to select one 'main' ethnic group among their ethnic group choices. This would avoid the allocation of individuals to one group or another, or the creation of mixed ethnic groups, in data output.

The method was tested using data from the Youth Connectedness Survey (Kukutai & Callister, 2009). While this survey was carried out amongst youth (age 10-14) and a degree of selection bias meant that results weren't directly generalisable to the national population, the findings provided an insight to youth views on ethnicity.

It was found that approximately 75% of those that reported more than one ethnicity could self-prioritise a main ethnic group. Of those that identified as Māori and European, the majority (just over half) chose European as their main ethnic group. If this method were applied to the population at large, assuming these results were representative of population choices, this would considerably reduce the count of Māori, resulting in the loss of information that may be important in research and policy making (Kukutai & Callister, 2009).

While the method of self-prioritisation allows for self-identification, and is therefore in some respect, consistent with Kaupapa Māori theory, it doesn't allow for all those who have identified as Māori to be given recognition in the production of final numbers which provide the data that informs policy making and resource allocation. A key Kaupapa Māori philosophy is to centralise Māori priorities. If we assume results of the Youth Connectedness study are more widely applicable, this method may serve to further marginalise Māori.

Comparator Group

When analyses are undertaken using ethnicity data, individual responses are often aggregated into larger ethnic groupings. For analysis of health disparities for Māori, comparisons are often made with the remainder of the population who have not identified as Māori, and usually termed 'non-Māori'. This is considered the most suitable comparison for example when monitoring Treaty obligations or ensuring Māori rights to good health are upheld. As has already been mentioned, Māori:non-Māori comparisons are consistent with Kaupapa Māori theory as this centralises the Māori reality. It must be clarified that 'non-Māori' is not an ethnic group, but a comparator group or reference group made up of multiple ethnic groups. Other commonly used comparator groups include European and non-Māori/non-Pacific. The choice of comparator will depend on the purpose of the study.

Summary – Ethnicity Chapter

Māori have the right to ethnicity data of the highest quality. Ethnicity refers to the way an individual chooses to identify, and ethnic groups are defined by cultural parameters. As such, ethnicity is a social construct and subject to political and cultural influences in society. Ethnicity is dynamic, individuals can change their ethnicity or choose to identify with more than one ethnic group. These factors present challenges for measuring ethnicity.

In Aotearoa there is a history of misclassification of ethnicity in official records. The persistent undercounting of Māori may be indicative of inadequate practices that have become accepted in the collection of ethnicity data. This misclassification has necessitated the development of statistical techniques in order to improve Māori estimates in health data. These should, however, be viewed as interim strategies and the focus should remain on improving the quality of ethnicity data.

Chapter three: Study Rationale

The following chapter will provide the rationale for this study, situating this within the overall philosophical need for this study from a Kaupapa Māori Research perspective and the more specific relevance for this particular study in terms of monitoring Māori health and inequalities. The overall and specific aims of the study will be detailed.

Philosophical Rationale

As described in the background to this study, a Kaupapa Māori approach has been taken in this research. This denotes the right of tangata whenua to high quality ethnicity data in order to determine the extent of inequities in health, and to monitor governmental progress towards equity. This provides the overall rationale for this study.

By placing Māori priorities and aspirations at the centre of any research, we are motivated to critique statistical methods and tools that are used to generate epidemiological data. In this study, different methods to measure ethnicity are 'tested' in order to analyse the effect on study results. It is important to constantly strive for high quality ethnicity data. Currently there are often various different ways of determining ethnicity in a study, such as using ethnicity recorded on an individual's NHI number, or recorded at time of hospital admission. Other methods have been developed in an attempt to improve population estimates for Māori, such as the ever Māori method, or development of adjusters. It is useful to have some idea of the impact of these methods in order to inform research design or to allow presentation of a 'range' of study results.

Additionally, as ethnicity is a value-laden construct, we may learn something further about the characteristics of the group of individuals identified when using the different methods to measure ethnicity.

Measuring Māori:non-Māori Inequalities in a Cohort Study

While previous work on different measures of ethnicity has largely focussed on numerator-denominator bias in the calculation of population rates, (Curtis E, 2005) fewer studies have been conducted to assess the impact of ways of measuring ethnicity within a cohort study.

The Unequal Treatment study is a prospective cohort study that aims to determine the contribution of unequal treatment in the health system to disparities between Māori and non-Māori with ischaemic heart disease. More details on the study will be provided in the methods section.

Cohort studies are commonly used in analytical health research to generate comparative ethnicity statistics. Different methods can be employed to measure ethnicity in a cohort study and it may be useful to know the extent to which the study results vary, if at all, with the use of the different methods. In effect, this study is a sensitivity analysis investigating the impact of different methods of measuring ethnicity. The likely effects of the different measures of ethnicity on the results of the study are expected to be small, as the numerator and denominator are derived from the same source, and ethnicity is defined using the same measure. However, it is important to confirm this hypothesis in order to justify the choice of approach used.

The way ethnicity is measured in studies is often queried, so despite the expectation that there will be little difference in results with the use of different measures of ethnicity, it may be expected that any measure used may be challenged or even criticised.

This study will also present population rates of IHD generated using different methods to measure ethnicity in order to demonstrate numerator denominator bias with the different methods used to measure ethnicity.

The following section will further define both cohort study and sensitivity analysis, and will describe the different measures of ethnicity employed in this study.

Cohort Study

A cohort study produces results that estimate the risk of a health event within a defined cohort (group of individuals) over a period of time. A variety of measures of association are possible from cohort studies (such as rate ratios, odds ratios, hazard ratios, standardised mortality ratios etc) and cohort study analyses can involve either internal or external reference groups (or sometimes both).

Sensitivity Analysis

A sensitivity analysis is the study of how the variation or uncertainty in the output of a study (such as odds ratios and hazard ratios) alters in response to different sources of variation in the input of a model (such as different measures of ethnicity) (Saltelli A et al, 2008).

The impact on the description of the cohort itself is also tested using different methods of measuring ethnicity in this study – age structure, proportion of male and female in the cohort, distribution of principle diagnoses and co-morbidities among the cohort. This is to determine whether the characteristics of each cohort differ when different methods are used to measure ethnicity.

A sensitivity analysis can be used to anticipate criticism (Kennedy, 2007). While in this context, criticism as such might not be expected in presentation of the results, challenges to or queries on the data are possible and even likely. The sensitivity analysis can therefore help 'defend' the choice of method used to measure ethnicity.

A sensitivity analysis aids in better assessing the uncertainty of study results and investigates the robustness of a study (Greenland, 1996). In so doing, it can:

- support decision making on choice of data (in this case, choice of method used to measure ethnicity)
- make study results or recommendations more understandable, credible, compelling or persuasive

- increase the understanding or quantification of the study, for example the relationships between input and output variables
- help identify any errors in the statistical model used

In this study, the sensitivity analysis is expected to also enhance understanding of the input variables and the methods used to determine them, namely; the four different methods used to measure ethnicity. The four different measures will be detailed in the Methods section.

In the original Unequal Treatment analysis for IHD data, the ever Māori classification was used. In the absence of any 'gold standard' ethnicity classification to measure against, this study will compare the other three methods of measuring ethnicity with the ever Māori method.

Possible Impacts of using Different Methods to Measure Ethnicity in this Study

There are two possible overall impacts of using different methods to measure ethnicity in a cohort study; firstly, the measures might identify different people, therefore producing a slightly different cohort with each method. Secondly, the use of different measures could produce samples of different size. While these two overall impacts are possible, it is not expected that either of them will produce substantial differences in this study.

1. Different Ethnicity Measures could Identify Different People

The different methods used to measure ethnicity could potentially identify groups of people with different characteristics, and as such, potentially introduce selection bias into the study.

Therefore if the different approaches are identifying groups of people with different characteristics, this may affect the size of the association between ethnicity and the outcome of interest (eg; procedure receipt or mortality). This is only likely to occur if there is a different ethnicity-outcome association between those included and those excluded in each group defined by the different measures of ethnicity. In order for the different ethnicity groupings to make an appreciable difference to the measures of association, there would have to be a major difference in the groupings, affecting a large number of individuals. As stated earlier, a difference of such a magnitude is not expected in this study.

Despite this, differences are still possible and warrant investigation in order to gain deeper understanding of the methods used. Such an analysis adds to the robustness of ethnicity measures that may be used in a cohort study and supports the right of Māori to good quality ethnicity data.

Where a difference in results may occur, is if one of the methods to measure ethnicity produced a markedly 'different' cohort of Māori compared to others. For example, one method might produce an 'older' group of Māori compared to the other methods, which could mean that these individuals have more advanced disease, or more co-morbidities (assuming both these are associated with age). In turn, this could affect whether these individuals receive certain treatments (dependent on their expected prognosis) or their risk of death following diagnosis. Therefore the question can be asked; *do the different methods used to measure ethnicity produce cohorts that differ considerably in terms of age, gender, principal diagnosis and presence of co-morbidities?*

An example might better illustrate this possibility. It is expected that the ever Māori method and restricted ever Māori method used to assign ethnicity might identify a noticeably different cohort. Using the ever Māori method to assign ethnicity, it may be possible that an 'older' or 'sicker' cohort is defined when compared to the other methods. As this method uses hospitalisation and mortality data to assign ethnicity, an individual has an increased chance of being classified as Māori with a greater number of hospitalisations, or a death registration.

If this were the case, when using the ever Māori method to assign ethnicity, we would expect to see a greater number of individuals assigned as Māori, an older mean age, a higher proportion of Māori in the older age groups, greater number with co-morbidities, and possibly higher receipt of procedures and higher mortality rates when compared to the restricted ever Māori method.

In comparison, using the restricted ever Māori method to assign ethnicity might produce a different cohort yet again. As ethnicity is not assigned at any time following diagnosis with IHD, it is possible that the cohort of Māori produced using this method is 'less unwell' compared to the cohort defined using ever Māori. If this were the case, we would perhaps expect to see lower levels of procedure receipt and mortality, and fewer co-morbidities for the Māori cohort identified.

2. Different Ethnicity Measures could Produce Cohorts of Different Sample Size

Undercount of Māori has been demonstrated in routinely collected ethnicity data (Ajwani et al., 2003b; McLeod, 2006; McLeod et al., 2000; Te Rōpū Rangahau Hauora a Eru Pōmare, 2000). More recently the use of the ever Māori method has been hypothesised to possibly overcount Māori (Harris, Purdie et al., 2007). Although there is no 'gold standard' method to measure ethnicity in this study to determine whether a count of Māori in the cohort is 'under' or 'over', it is expected that the sample sizes of Māori may differ slightly with use of the different methods to measure ethnicity in this cohort. As mentioned earlier, the difference in sample sizes generated with the different measures of ethnicity are not expected to be considerable in this study.

Māori comprise approximately 14-15% of the general population (Statistics New Zealand, 2006a). While they experience a higher incidence of ischaemic heart disease than non-Māori, (Robson & Harris, 2007) the actual *number* of individuals in this cohort likely to be counted as Māori (regardless of the method used) will still be considerably less than non-Māori, particularly considering the older age structure of

the New Zealand European population which comprise a large proportion of the non-Māori group. The issue of study power therefore will be most pertinent for Māori data as this is dependent on sample size.

Different sample sizes can affect the precision of the estimates (confidence intervals) and the power of the study to identify an association (p-values). A 95% confidence interval gives the plausible range in which the true underlying population estimate is likely to lie. A larger sample size (in general) results in higher study precision and narrower 95% confidence interval. P-values indicate the likelihood that any association found (odds ratio/ hazard ratio) is due to chance alone, assuming no such association actually exists. The size of the population studied and the strength of association impacts on the magnitude of a p-value, in general the larger the sample size, and bigger the strength of association, the smaller the p-value. In this study, the overall sample size is constant regardless of which method is used to measure ethnicity, but the size of sub-populations within the cohort (Māori, non-Māori) alters with each method. A reasonably substantial change in the size of the Māori population would be required in order to see a change in either confidence interval or p-value.

Therefore this study considers the question: *How do the different methods used to measure ethnicity change the sample size? How do these changes affect the power to detect differences, and the precision of the estimates?*

In this study it is expected that the sample size of Māori and non-Māori might change slightly with the different methods used to measure ethnicity. These are discussed in further detail as follows.

Ever Māori

This method is likely to produce the highest numbers of Māori in the cohort as ethnicity is determined from two data sources, and over the longest period of time compared to the other methods – hospitalisations from 1988-2004 and death registrations from 2000-2006. The longer period of time increases the chance of an

individual being identified as Māori and therefore being counted using the ever Māori method.

Index Admission

This method used to measure ethnicity depends largely on the accuracy of ethnicity recorded at the time of first hospital admission for an IHD event. It is expected that use of this method will produce the smallest sample size in this study.

National Health Index

Assuming some error of recording ethnicity at admission (and therefore undercount of Māori) and that repeated admissions provide opportunity for more accurate recording of ethnicity, the NHI method could produce slightly higher numbers of Māori in the cohort (compared to using ethnicity recorded at index admission). Numbers of Māori produced would still likely be lower than those produced by use of the ever Māori method.

Restricted Ever Māori

An interesting comparison will be made with use of the restricted ever Māori method and use of ever Māori method to assign ethnicity. It has been hypothesised that the ever Māori method may overcount Māori. This overcount in recent years is possibly due to improved ethnicity data collection methods, or may be due to increased chance of false positives with increased hospital admissions (or death). The restricted ever Māori method does not use mortality data to assign ethnicity, whereas the ever Māori method does. Following diagnosis of IHD it is assumed an individual is likely to undergo further hospital treatment, therefore the chance of false positives is increased. The restricted ever Māori method does not use hospital data following initial hospitalisation for IHD to assign ethnicity.

Therefore, it is expected that this method would produce a lower number of Māori in the cohort compared to use of the ever Māori method, but a higher number is likely compared to the use of either index admission ethnicity or NHI. The restricted ever Māori method assigns individuals as Māori using data from 1988 up to admission (2000-2004). Therefore there are more chances of an individual being recorded as

Māori (either false positive or true positive) over this time, compared to ethnicity determined at one point in time as with index admission ethnicity or NHI.

It is not expected that the results from internal analysis within the cohort study (such as receipt of cardiac procedures) will change greatly with the use of different methods to measure ethnicity, as there is no external denominator. It would require that the groups of Māori identified in the cohort using the different ethnicity measures would differ considerably, and that the sample sizes would be significantly different. However concern has been raised, in the course of the original Unequal Treatment study on ischaemic heart disease, therefore it has become important to further examine this issue.

Specific Aims of this Study

The overall aim of this dissertation is to determine *the implications of using different methods to measure ethnicity in a cohort study.*

A sensitivity analysis will be performed using four different methods to measure ethnicity:

- The ever Māori method ("**ever Māori**")
- Ethnicity recorded on the individual's first admission for an IHD event ("**index admission**")
- Ethnicity recorded on the individual's National Health Index number ("**NHI**")
- Using the ever Māori method up to and including an individual's first admission for an IHD event ("**restricted ever Māori**")

The sensitivity analysis will explore the effect of using different methods to measure ethnicity on cohort characteristics and key study outcomes including the distribution of principle diagnoses and co-morbidities, odds ratios for principle diagnosis comparing Māori to non-Māori and hazard ratios for receipt of IHD procedures and deaths, comparing Māori to non-Māori.

The study therefore intends to address the more specific sub-aims of whether the four different methods used to measure ethnicity impact on:

- population rates of ischaemic heart disease? (assuming a common denominator)
- the age structure of Māori in the cohort?
- the proportion of Māori in the cohort who are male or female?
- the distribution of principal diagnoses amongst Māori in the cohort?
- the distribution of co-morbidities amongst Māori in the cohort?

- Māori:non-Māori odds ratios for principal IHD diagnosis ?
- Māori:non-Māori hazard ratios for receipt of IHD procedures? (during first admission and also any time following admission)
- Māori:non-Māori hazard ratios for risk of death following diagnosis?
- Sample size?
- Precision of estimates and significance of differences?

METHODS

The Unequal Treatment Project

Background – Unequal Treatment

In 2005, Te Rōpū Rangahau Hauora a Eru Pōmare, Otago University, Wellington, received funding from the Health Research Council for a research project titled *'Unequal Treatment: the Role of Health Services'.* The intent was to investigate the contribution of unequal treatment in the New Zealand health system to unequal health outcomes between Māori and non-Māori. Three areas of health were to be investigated; ischaemic heart disease, obstetric procedures and adverse birth outcomes, and cervical cancer (Te Rōpū Rangahau Hauora a Eru Pōmare, 2007).

The project was conducted over a three year period and had both quantitative (cohort studies) and qualitative (focus group) aspects. Quantitative analysis of national datasets was undertaken followed by qualitative engagement with health care workers and clinicians in order to gain a deeper understanding of the data. Clinical reference groups were established consisting of clinicians, nurses, and researchers with expertise in each particular field, nurse navigators and a medical coder. These groups were consulted throughout the study. The final stage of the process was to develop patient information resources specifically targeted to Māori patients, whānau and communities.

Ischaemic heart disease is a leading cause of premature death among Māori. While developments in health care for heart disease have contributed to the significant decline in deaths overall, Māori have not benefited to the same extent as non-Māori from these advancements. Instead, ethnic disparities in heart disease mortality have widened (Ajwani et al., 2003c; Tobias, Sexton, Mann, & Sharpe, 2006).

Evidence also shows that Māori receive lower rates of potentially life-saving, or quality of life-enhancing, heart procedures (Westbrooke et al., 2001). Clinicians

raised the question as to whether this difference in procedure receipt was due to higher rates of co-morbid conditions in Māori patients with ischaemic heart disease. The Unequal Treatment study sought to answer this question. Therefore the overall aim of the Unequal Treatment (IHD) Project was: *to determine if ethnic disparities in receipt of ischaemic heart disease procedures, mortality and survival exist in a cohort of Māori and non-Māori men and women, after controlling for relevant co-morbid conditions.*

Study Methods – Unequal Treatment (IHD)

Participants

A cohort of all individuals admitted to hospital between 1 January 2000 to 31 December 2004 with a primary diagnosis of angina or myocardial infarction (ICD-10 code I20-I25) was identified from the New Zealand Health Information System's (NZHIS) publicly funded hospital discharge file. Included were admissions that were both routine (not transferred from another facility) and acute (not arranged via waiting list or private elective). Waiting list, arranged admissions and transfers were more likely to be admitted specifically for an intervention and the inclusion of these patients would influence results. Therefore, these patients were excluded. Individuals were also excluded if they had a previous public hospital admission for IHD since 1988 for public hospital admissions, if they were diagnosed with non-acute IHD (chronic IHD and other angina) or if under 18 years of age.

The cohort was followed until the end of 2004 for receipt of associated procedures; angiography, percutaneous cardiac intervention (PCI), coronary artery bypass and graft (CABG), and through to 31 December 2006 for death. Deaths with ICD-10 codes I20-I25 were included and individuals censored if the cause of death was other than IHD.

Co-morbidities

Co-morbid conditions were ascertained from secondary diagnoses associated with the index admission (identified using the individual's encrypted NHI number). Co-morbid conditions likely to affect receipt of heart procedures were confirmed with the clinical reference group[ix] and were; heart failure, peripheral vascular disease, chronic pulmonary disease, rheumatological disease, diabetes, renal failure, any cancer, obesity, dementia, other mental health illness, smoking history and current smoker status.

Analysis

The measures of association produced are odds ratios and hazard ratios for Māori vs non-Māori.

Logistic regression modelling was used to calculate odds ratios for selected co-morbid conditions and disease severity, the odds of receiving cardiovascular interventions (or dying) during the admission, for Māori and non-Māori patients, unadjusted and adjusted for age, sex, severity and co-morbidity. Proportional hazards regression was used to compare the relative chance of receiving procedures or of death after admission, for Māori vs non-Māori, unadjusted and adjusted for age, sex, disease severity and co-morbidity.

An odds ratio (OR) gives a measure of effect size and describes the strength of association between two binary or categorical data values (Viela, 2008). In the unequal treatment study odds ratios will be calculated for principal diagnosis, and demonstrate the odds of a Māori individual being diagnosed with a certain IHD condition compared to the odds of a non-Māori being diagnosed with the same condition.

[ix] The clinical reference group consisting of cardiologists, nurses, researchers, a nurse navigator and a medical coder, was established and consulted throughout the duration of the Unequal Treatment project.

A hazard ratio (HR) in survival analysis is the effect of an explanatory variable (eg ethnicity) on the hazard or risk of an event (eg mortality). Time is factored into this calculation so that the *hazard rate* can be described as the 'the limit of the number of events per unit time divided by the number at risk as the time interval decreases' (Altman, 1991). In this study HRs are calculated for receipt of IHD treatment procedures (separately for 'during first admission' and 'any time following admission'), and for mortality.

Conclusions – Unequal Treatment

The results of the study showed that although the presence of co-morbidities made some contribution to lower procedure receipt for Māori, it did not explain the entire disparity.

For the purpose of the original study, ethnicity was classified using the ever Māori method. At the time, researchers involved in the study queried whether the study results would differ if ethnicity were measured in the cohort using alternative methods. This provided the motivation for this dissertation.

Methods for this Dissertation

Ethnicity Measures

Ever Māori

Ethnicity on the hospital discharge event for entry into the cohort was assigned as Māori according to whether or not it or any admission for that patient (as identified by their unique NHI identifiers) or any cancer registration had been recorded as Māori, either solely or total, or they had been recorded as Māori on a death certificate or NHI. To assign ethnicity using the ever Māori method, ethnicity on hospital

admission data from 1 January 1988 to 31 December 2004 and death registration data from 1 January 2000 to 31 December 2006 was used.

Index Admission

An individual within the cohort was counted as Māori if this was the ethnicity recorded on the first (index) hospital admission for a routine acute ischaemic heart disease event, using prioritised ethnicity.

National Health Index number

An individual within the cohort was measured as Māori if this was the ethnicity attached to their unique NHI number. The ethnicity field on the National Health Index is updated when new health information for an individual is entered into the system. Using this method, ethnicity was defined as at the date of data extraction for the study: 20 February 2006.

Restricted 'Ever Māori'

An individual from the cohort was assigned to the Māori ethnic group if they were classified as Māori on any hospital admission or cancer registration prior to and including the first admission for an ischaemic heart disease event. Hospital admission data dates back to 1 January 1988.

Assigning cohort individuals as non-Māori

For all four methods used, all remaining records (not assigned as Māori) were classified as non-Māori, including those with no ethnicity specified.

Table one below shows the time periods involved in each method of measuring ethnicity.

Table 1: Summary of ethnicity classifications, showing time periods over which ethnicity is measured

	1988-9	1990-1	1992-3	1994-5	1996-7	1998-9	2000-1	2002-3	2004-5	2006-7
							Cohort defined 1 Jan 2000 – 31 Dec 2004			
Ever Māori – individual classified as Māori if they have ever been recorded as Māori on any hospital data from 1988 to 2004, cancer registration to 2004, death registration from 2000 to 2006 or NHI	Hospitalisation data from 1 Jan 1988 to 31 Dec 2004									
							Death registration to 31 Dec 06			
Index admission – individual classified as Māori if they were recorded as Māori on their first hospital admission for an IHD event between 2000-2004							First hospital admission for acute IHD event			
NHI – individual classified as Māori if recorded as Māori on National Health Index as at 20 February 2006 (date of data extraction) [x]										20 Feb 06
Restricted ever Māori – individual classified as Māori if they have ever been recorded as Māori on hospital records or cancer registration up to and including first hospital admission for an IHD event between 2000-2004	Hospitalisation data from 1 Jan 1988 to first admission for IHD event between 2000-2004									

[x] Note that ethnicity could have been recorded any time between 1988 to 2006

Analysis

Cohort Description

Percentages were calculated for Māori and non-Māori (using each of the four methods to measure ethnicity) to show the relative percentages within these populations of:

- male or female
- principal diagnosis
- selected co-morbidities

Data for principal diagnosis is age standardised (see below) to 2001 Māori standard population.

Age Distribution

For the total cohort of Māori with IHD, the proportion of individuals in each five-year age group was calculated, and similarly for the non-Māori cohort, to demonstrate any differences in age profile between the two groups. This was carried out for each of the four measures of ethnicity.

The proportions of Māori (out of total Māori and non-Māori) in each five year age group were also calculated.

Population Rates and Ratios

Denominators were obtained from Statistics New Zealand estimated usually resident population at 30 June for each year (prioritised ethnicity).[xi] To determine non-Māori numbers, Māori population estimates were subtracted from the total New Zealand population estimates.

[xi] See Appendix 1 for population denominators

Population (incidence) rates of hospitalisations for IHD were calculated for each of the four ethnicity measures, for Māori and non-Māori. Rates are expressed per 100,000 per year and calculated:

$$\text{Incidence rate of IHD} = \frac{\text{hospital admissions for IHD}}{\text{population}} \times 100{,}000$$

Rates were age standardised (see below) to 2001 Māori standard population.

Māori:non-Māori rate ratios were calculated by dividing the age-standardised Māori rate per 100,000 by the age-standardised non-Māori rate per 100,000. A rate ratio higher than one indicates that Māori have a higher risk than non-Māori.

Age Standardisation

The Māori population has a relatively young age structure compared to the non-Māori population. This necessitates adjusting for age when comparing health outcomes.

Population rates have been age-standardised using direct standardisation. Age-specific rates are multiplied by a weighting factor from a standard population and then summed to obtain a standardised rate. This age-standardised rate is the rate that would be expected for each population (Māori or non-Māori) if this population had the same age structure as the standard population. Age standardised rates are artificial and only to be used when comparing rates for the two population groups.

Data in this dissertation has been age standardised to the 2001 Māori standard population. Weightings have been provided in appendix two.

Odds Ratios

For Māori:non-Māori comparisons, an odds ratio greater than 1.0 indicates higher odds of a given outcome for Māori. Logistic regression modelling was used to calculate odds ratios for principal diagnosis for each of the methods used to measure ethnicity. This demonstrates the odds of a Māori individual being diagnosed with a certain type of IHD condition compared to the odds of a non-Māori being diagnosed with the same condition.

Hazard Ratios

Proportional hazards regression was used to compare the relative chance of

- receiving cardiac procedures during first (index) admission
- receiving cardiac procedures any time following first (index) admission
- death any time following admission

for each of the methods used to measure ethnicity. Data were unadjusted and adjusted for age, sex and co-morbidity. Data were also analysed by type of diagnosis.

Confidence Intervals and P-values

There is always a degree of uncertainty with estimates of rates and ratios in a study. A 95% confidence interval around an estimate indicates the range of values that have a 95% probability of including the true population value (rate or ratio) (Beaglehole, Bonita, & Kjellstrom, 2006).

P-values can also be used to test for statistical significance or the role of chance in explaining findings. In general, a p-value less than 0.05 is considered statistically significant. In most cases, p-values do not provide any information beyond that provided by confidence intervals.

Sensitivity Analysis

For the purpose of this dissertation a sensitivity analysis was performed. The analysis as described above was conducted a total of four times on this cohort, measuring patients as either Māori or non-Māori using the four different classifications; ever Māori, ethnicity as recorded during the index admission for the ischaemic heart disease event, ethnicity recorded on the individual's National Health Index (NHI) number at time of data extraction for the study, and using the restricted 'ever Māori' classification for all admissions and cancer registrations up to and including the admission for the first IHD event.

The results for each ethnicity classification were compared with the original analysis conducted using the 'ever Māori' classification.

Statistically significant differences were compared between the four measures of ethnicity. Potential biases and practical issues for each method were also considered.

RESULTS

Cohort Description

This cohort contains 39,281 individuals, made up of all those individuals admitted to a public hospital for a routine acute ischaemic heart disease event between 1 January 2000 and 31 December 2004 with no previous hospital admission for IHD. Using the ever Māori method to assign ethnicity produces the greatest number of Māori in the cohort (3,371). Individuals with no ethnicity recorded comprised 2.8% of the cohort (1,111 / 39,281) and were classified as non-Māori using this method. The restricted ever Māori method produced the next highest number of Māori (3,094), followed by NHI ethnicity (3,073) and then Index Admission ethnicity (2,953) (see Table 2).

The proportion of the cohort that is counted as Māori using the ever Māori method is 8.6%. Using NHI ethnicity or Restricted ever Māori produces slightly lower proportions, 7.9% and 7.8% respectively, and measuring ethnicity using index admission produces yet a lower proportion of 7.5% Māori.

Sex

Table 2 shows the overall proportion of Māori males and females is similar for each method used to measure ethnicity. Just over 55% of Māori in this cohort are male, and just under 45% are female. The pattern is similar for non-Māori, although there is a higher proportion of non-Māori male in the cohort; approximately 59% of non-Māori are male, and 41% female.

Principal Diagnosis

Numbers and rates of Māori or non-Māori who are diagnosed with each principle diagnosis are given in Table 2. Age-standardised rates (ASR) are age-sex standardised to 2001 Māori standard population.[xii]

As expected, for all methods of measuring ethnicity, age-sex standardised rates were higher for Māori for all diagnoses except STEMI-other site and 'other' IHD when compared to data for non-Māori (Table 2). Using the ever Māori method produced systematically higher Māori rates (and numbers) for each of the diagnoses (except 'other' IHD) compared to the other methods used to measure ethnicity, which produced comparatively similar rates to each other. For example the age-sex standardised rate for Māori using ever Māori for unstable angina was 37 per 100,000, the corresponding data using other methods to measure ethnicity were 33.3, 34.3 and 34.8 using index admission ethnicity, NHI ethnicity and the restricted ever Māori method to measure ethnicity respectively. Using index admission ethnicity produced lower rates for all diagnoses.

The age-sex standardised rates for all diagnoses for non-Māori varied slightly with use of the different methods to measure ethnicity. Although the difference was small as expected, using the ever Māori method produced consistently lower rates for all diagnoses, and using index admission ethnicity slightly higher rates.

Co-morbidities

Data on co-morbidities is age-sex standardised to 2001 Māori standard population and is displayed in Table 2. For all methods of measuring ethnicity, Māori age-sex standardised rates were considerably higher when compared to non-Māori for all co-morbidities, apart from rheumatological disease, which was similar. This is particularly noticeable for heart failure, chronic pulmonary disease, diabetes mellitus,

---

[xii] See Appendix Two for 2001 Māori standard population weightings

renal failure, obesity and smoking, where for all methods of measuring ethnicity, Māori rates were more than twice those of non-Māori.

Use of the ever Māori method to assign ethnicity produces Māori rates higher for each co-morbidity when compared to use of the other three methods. For example, the rate of Māori diagnosed with diabetes mellitus as a co-morbidity was 34.0 per 100,000 using ever Māori ethnicity, and 30.8, 31.4 and 32.0 using index admission ethnicity, NHI ethnicity and restricted ever Māori method to measure ethnicity respectively.

Use of the restricted ever Māori method usually produced the next highest rates (compared to the other methods used to measure ethnicity) followed by NHI ethnicity then index admission. This pattern was seen in the Māori rates produced for heart failure, diabetes, chronic pulmonary disease, renal failure and smoking history. The pattern varied slightly for the other co-morbidities.

Rates for the non-Māori population did not vary greatly with the use of the four different methods to measure ethnicity. This means that using the ever Māori method to assign ethnicity, compared to other methods used to measure ethnicity, produced higher ratios and greater absolute differences between Māori and non-Māori data for most of the co-morbidities (ratios data not presented).

Table 2: Cohort description; patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004. Numbers and age-standardised rates, using different methods to measure ethnicity.

		Ever Māori				Index admission				NHI				Restricted Ever Māori			
		Māori (n=3,371)		non-Māori (n=35,910)		Māori (n=2,953)		non-Māori (n=36,328)		Māori (n=3,073)		non-Māori (n=36,208)		Māori (n=3,094)		non-Māori (n=36,187)	
		no.	ASR	no.	ASR	no.	ASR	no.	ASR	no.	ASR	no.	ASR	no.	ASR	no.	ASR
Total		3,371	8.6	35,910	91.4	2,953	7.5	36,328	92.5	3,073	7.8	36,208	92.2	3,094	7.9	36,187	92.1
Gender	Female	1,502	44.6	14,876	41.4	1,326	44.9	15,052	41.4	1,357	44.2	15,021	41.5	1,386	44.8	14,992	41.4
	Male	1,869	55.4	21,034	58.6	1,627	55.1	21,276	58.6	1,716	55.8	21,187	58.5	1,708	55.2	21,195	58.6
Principal diagnosis	STEMI – anterior	406	13.5	4,103	9.7	351	11.6	4,158	9.9	370	12.3	4,139	9.8	365	12.1	4,144	9.9
	STEMI – other site	432	14.3	5,484	14.0	365	12.1	5,551	14.2	395	13.2	5,521	14.1	378	12.6	5,538	14.1
	Non STEMI	1,016	33.4	11,566	24.9	889	29.2	11,693	25.3	916	30.2	11,666	25.2	938	30.9	11,644	25.1
	MI unspecified	361	11.8	4,163	7.5	309	10.1	4,215	7.7	319	10.5	4,205	7.6	327	10.7	4,197	7.6
	Unstable angina	1,139	37.0	10,253	24.2	1,025	33.3	10,367	24.6	1,056	34.3	10,336	24.5	1,070	34.8	10,322	24.4
	other	17	.06	341	0.7	14	0.5	344	0.7	17	0.6	341	0.7	16	0.5	342	0.7
Co-morbidities	Heart failure	600	19.6	6,356	9.1	535	17.5	6,421	9.2	536	17.5	6,420	9.2	554	18.1	6,402	9.2
	Peripheral vascular	90	2.9	1,215	2.0	80	2.6	1,225	2.1	81	2.7	1,224	2.1	86	2.8	1,219	2.0
	Chronic pulmonary	255	8.3	2,012	3.3	230	7.5	2,037	3.4	232	7.6	2,035	3.4	237	7.7	2,030	3.4
	Rheumatological	18	0.6	275	0.5	17	0.5	276	0.5	18	0.6	275	0.5	18	0.6	275	0.5
	Diabetes mellitus	1,035	34.0	5,419	11.6	936	30.8	5,518	11.9	954	31.4	5,500	11.9	974	32.0	5,480	11.8
	Renal failure	345	11.4	2,607	3.9	310	10.3	2,642	4.0	305	10.1	2,647	4.0	325	10.8	2,627	3.9
	Any Cancer	68	2.3	822	1.3	60	2.0	830	1.4	60	2.0	830	1.4	62	2.1	828	1.4
	Obesity	381	12.6	1,162	3.6	345	11.4	1,198	3.7	358	11.8	1,185	3.6	354	11.7	1,189	3.6
	Dementia	34	1.1	592	0.6	28	0.9	598	0.6	28	0.9	598	0.6	31	1.0	595	0.6
	Other mental health	102	3.3	1,206	2.5	86	2.8	1,222	2.5	88	2.9	1,220	2.5	95	3.1	1,213	2.5
	Smoking history	834	27.5	9,771	20.8	729	24.0	9,876	21.0	760	25.0	9,845	20.9	770	25.4	9,835	20.9
	Smoking	1,348	44.4	6,755	21.6	1,203	39.6	6,900	22.2	1,270	41.8	6,833	21.9	1,253	41.2	6,850	22.0

Notes: ASR = age standardised rate per 100,000. Data for principal diagnosis and co-morbidities is standardised for sex and age to 2001 Māori standard population. Gender percentage = proportion of either Māori or non-Māori that are this gender.

Age

Age Distribution within Cohort

The different methods of measuring ethnicity make negligible difference to mean age at admission of both Māori females (approximately 60 years) and Māori males (approximately 57.5 years) in the cohort, as seen in Table 3. Even less variation is seen in the data for non-Māori who have a higher median age at diagnosis for both females (approximately 73.5) and males (approximately 66 years) than Māori.

Table 3: Patients admitted to hospital for a routine acute ischaemic heart disease event 2000-2004; mean age at admission, by sex, using different methods to measure ethnicity

		Ethnicity n(cohort) = 39,281							
		Ever Māori		Index admission		NHI		Restricted ever Māori	
		Māori (n=3,371)	non-Māori (n=35,910)	Māori (n=2,953)	non-Māori (n=36,328)	Māori (n=3,073)	non-Māori (n=36,208)	Māori (n=3,094)	non-Māori (n=36,187)
Female	no.	1,502	14,876	1,326	15,052	1,357	15,021	1,386	14,992
	Mean age	60.4	73.5	60.0	73.4	59.9	73.4	60.0	73.4
Male	no.	1,869	21,034	1,627	21,276	1,716	21,187	1,708	21,195
	Mean age	57.6	66.2	57.4	66.1	57.3	66.1	57.6	66.1

Ever Māori: 'Māori' on any hospital admission 1988-2004 or death registration 2000-2006
Index Admission: 'Māori' on first hospital admission for acute routine IHD event
NHI: 'Māori' on National Health Index number as at 20 February 2006
Restricted Ever Māori: 'Māori' on any hospital admission from 1988 up to and including first admission for acute routine IHD event between 2000-2004

The age distribution of Māori and non-Māori patients, using the four different methods to measure ethnicity is shown in Table 4. The younger age distribution of Māori diagnosed with ischaemic heart disease can be clearly seen in Figure 1. There is little difference in distribution with the use of different methods to measure ethnicity. Variation seen in Māori data is due to lower numbers of Māori in the cohort compared to non-Māori resulting in more statistical instability.

It appears that using the ever Māori method to assign ethnicity produces a slightly 'older' cohort of Māori compared to the other three methods. Figure 1 shows that in the younger age groups (20-59 years), the proportion of Māori in each five-year age group tends to be slightly lower when using the ever Māori method to assign ethnicity compared to the other three methods. Similarly, in the older age groups 70 to 85+ years, the proportion of Māori using the ever Māori method is slightly greater in comparison to the other methods used to measure ethnicity. For example, as seen in Table 4 in the 75-79 year age group, proportions of Māori were 5.4% using the ever Māori method, and 4.9%, 4.7% and 5.0% using index admission ethnicity, NHI ethnicity and restricted ever Māori method to measure ethnicity respectively. However, the overall difference is not very pronounced.

Figure 1: Age distribution of Māori and non-Māori patients admitted to hospital for a routine acute ischaemic heart disease event 2000-2004 using different methods to measure ethnicity

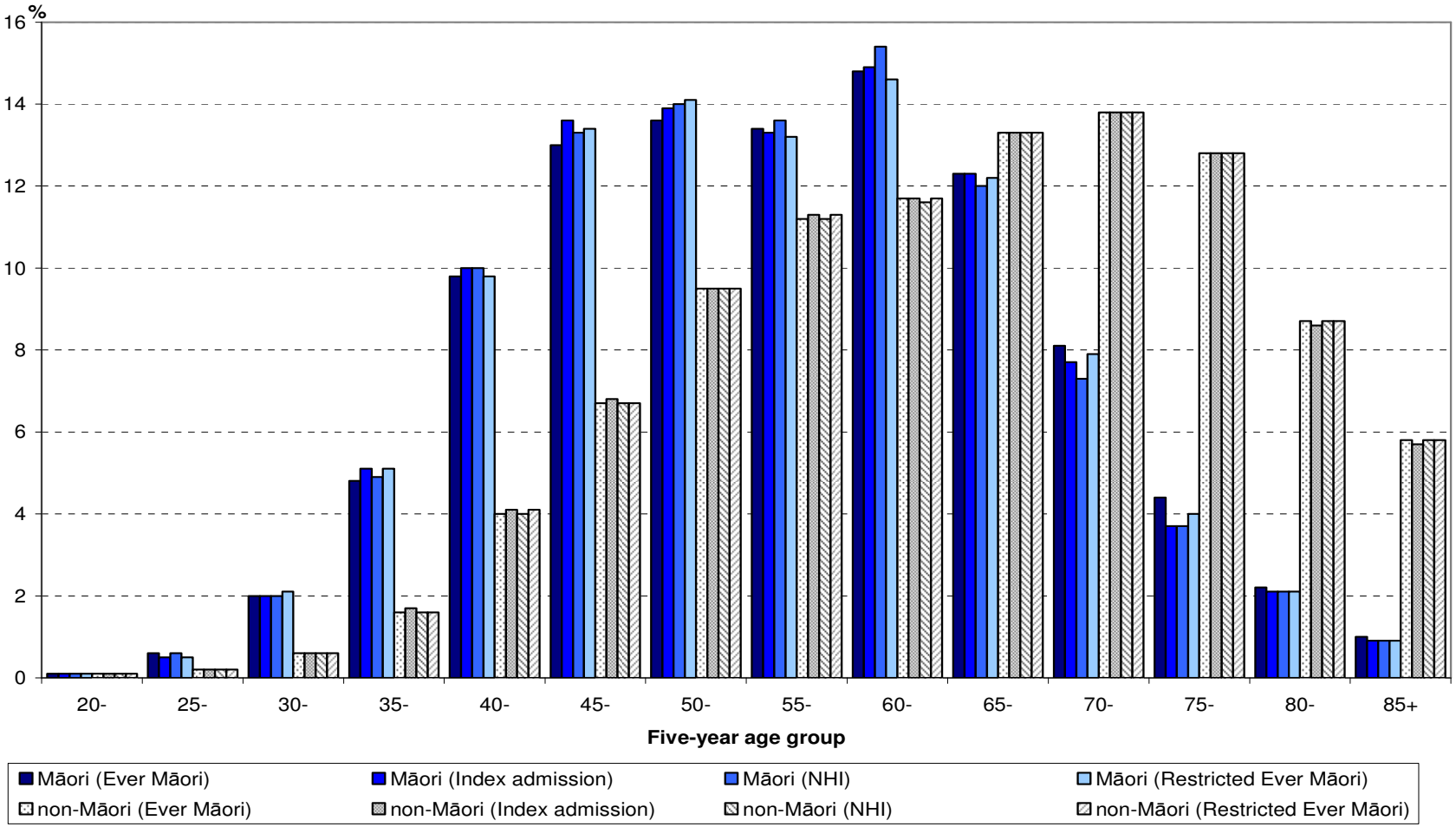


Table 4. Māori patients admitted to hospital for a routine acute ischaemic heart disease event 2000-2004; age distribution, 5-year age group, using different methods to measure ethnicity

Five-year age group	Ethnicity			
	Ever Māori % Māori (n-3,371)	Index admission % Māori (n=2,953)	NHI % Māori (n=3,073)	Restricted ever Māori % Māori (n=3094)
15-19	0.0	0.0	0.0	0.0
20-	0.1	0.0	0.1	0.1
25-	0.4	0.4	0.5	0.4
30-	1.5	1.6	1.6	1.6
35-	3.9	4.1	4.0	4.1
40-	8.3	8.4	8.6	8.3
45-	12.4	12.9	12.6	12.9
50-	13.3	13.8	13.8	13.9
55-	14.0	14.0	14.2	13.8
60-	14.8	14.7	15.4	14.5
65-	12.5	12.5	12.3	12.6
70-	8.8	8.4	8.2	8.5
75-	5.4	4.9	4.7	5.0
80-	3.2	2.9	2.8	3.0
85+	1.5	1.3	1.3	1.3
Total	100	100	100	100

Figures 2 and 3 display age distribution separately for male and female Māori in this cohort. The younger age at diagnosis experienced by Māori males is noticeable in these graphs, particularly in the 20-44 age groups. There is some variation between each method used to measure ethnicity in the proportion of Māori in each age group for both males and females.

Again, the ever Māori method of assigning ethnicity appears to produce a slightly 'older' cohort of Māori. A higher proportion of Māori over 70 is observed using the ever Māori method compared to other methods of measuring ethnicity, for both males and females. A lower or similar proportion of Māori up to the age of 54 for males and 59 for females is observed, when using the ever Māori method to assign ethnicity in comparison to the other three methods.

Figure 2: Age distribution of Māori and non-Māori FEMALES first admitted to hospital for an acute routine ischaemic heart disease event (2000-2004) using different methods to measure ethnicity

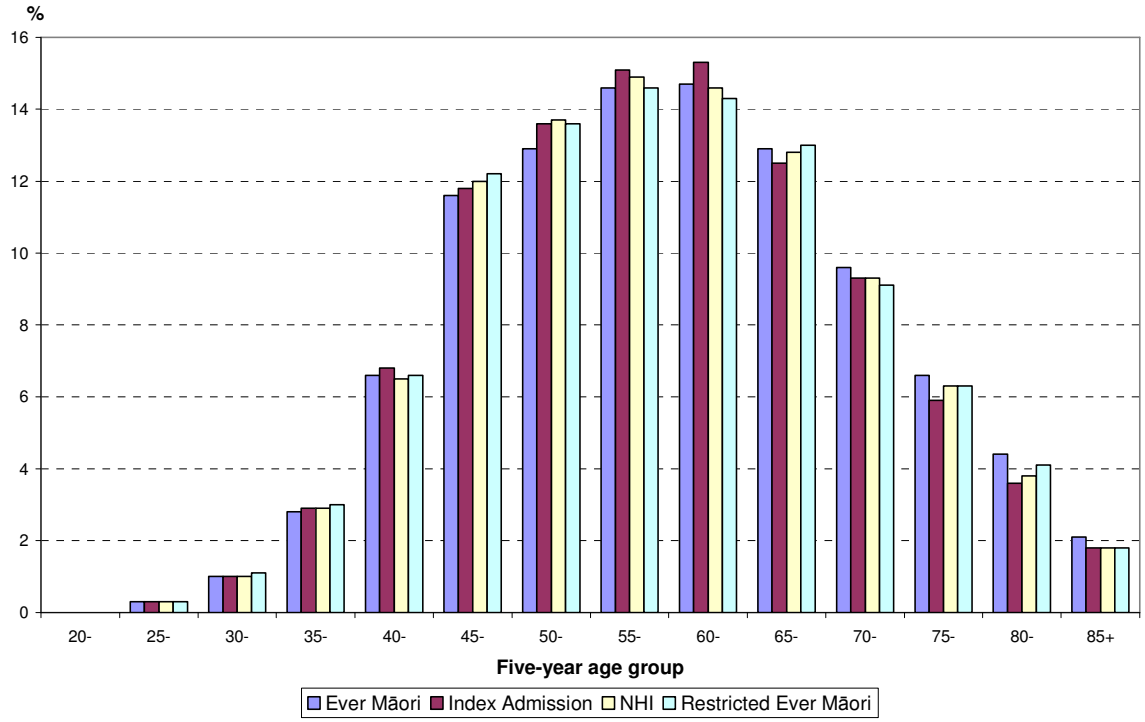
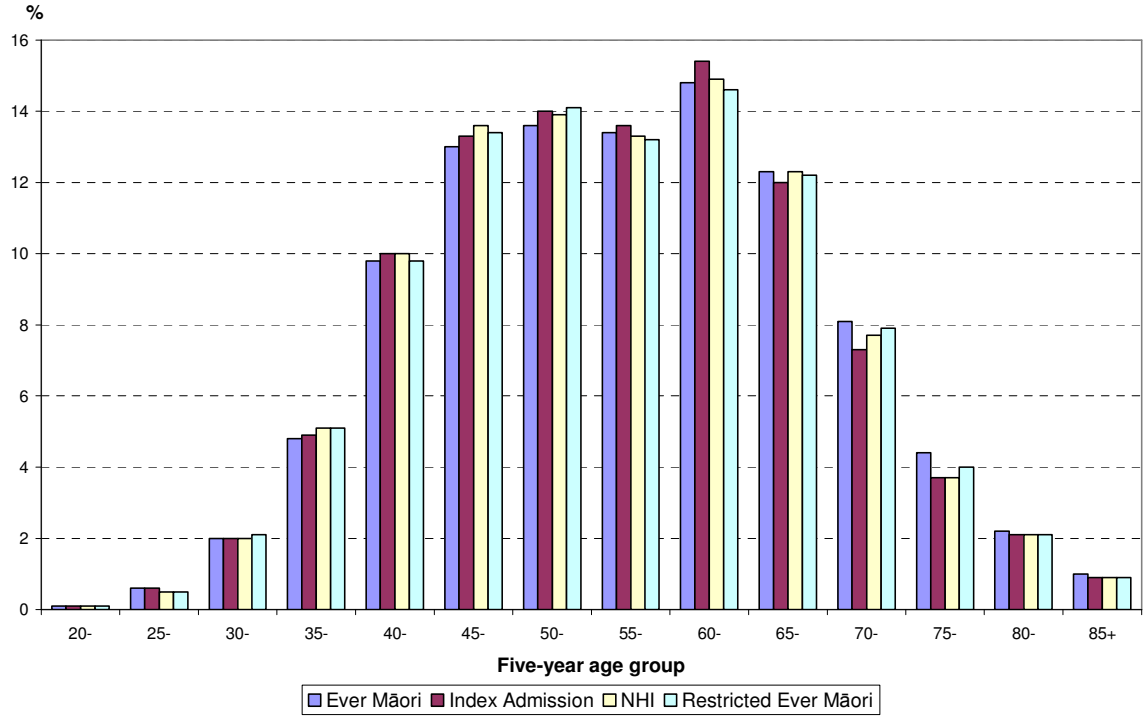


Figure 3: Age distribution of Māori and non-Māori MALES first admitted to hospital for an acute routine ischaemic heart disease event (2000-2004) using different methods to measure ethnicity



Age

Proportion of Māori or non-Māori in each Age Group

Figure 4 shows the proportion of Māori in the total cohort for each five-year age group. Data for this graph is provided in Table 5.

This pattern, showing higher proportions of Māori in younger age groups likely reflects both the younger disease profile of Māori (as seen in Figure 1) and the younger age structure of the Māori population compared to non-Māori.

This pattern does not change considerably with the different methods used to measure ethnicity. In general, using the ever Māori method consistently produces a higher proportion of Māori in each age group from age 30 onwards, with index admission ethnicity producing the lower proportion. This reflects the general pattern of actual numbers of Māori generated overall using each method to measure ethnicity.

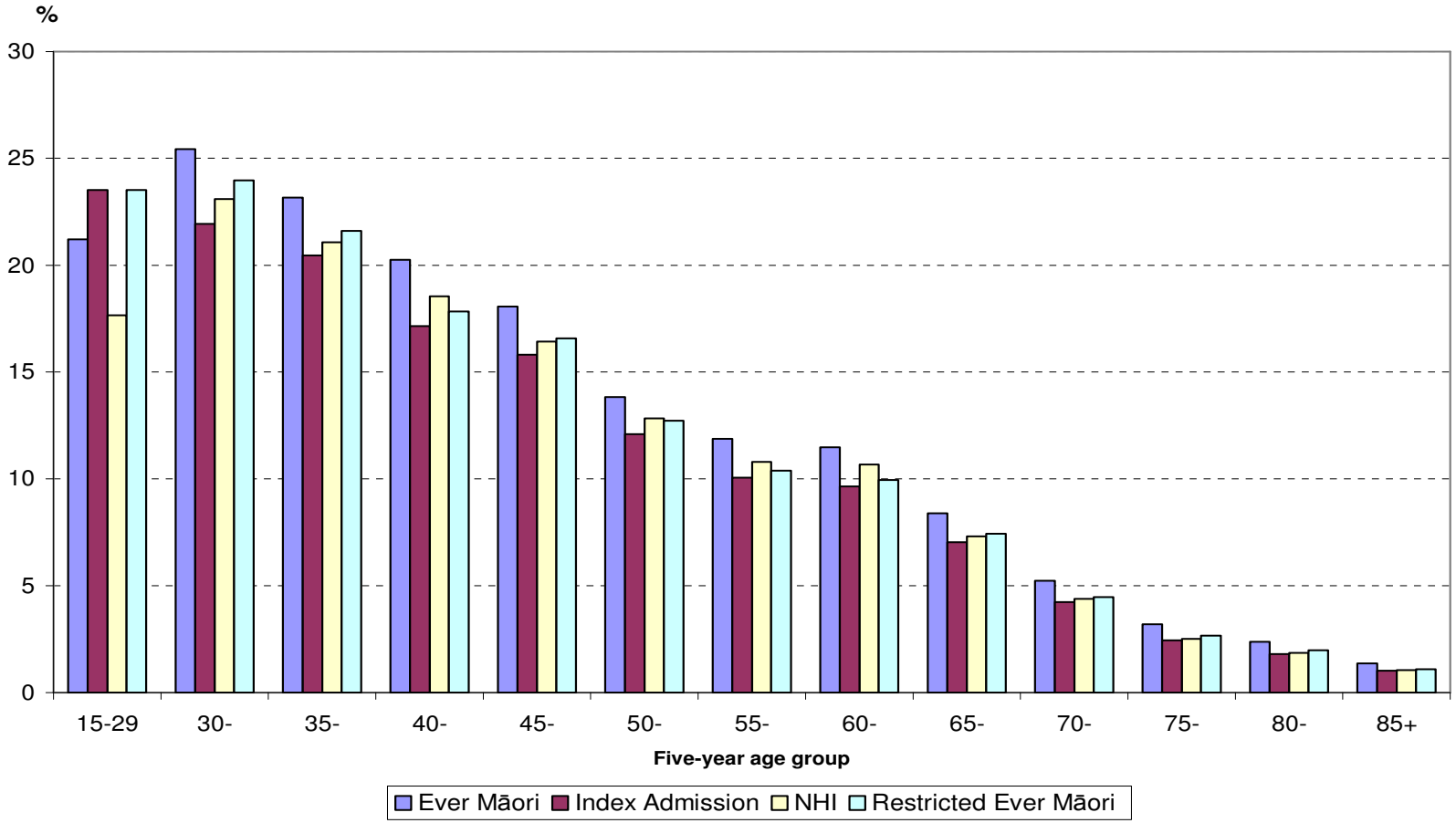
Table 5: Proportion of Māori in each five-year age group, patients first admitted to hospital for acute routine ischaemic heart disease event 2000-2004, using different methods to measure ethnicity

Age (years)	Ever Māori (n = 3,371)		Index Admission (n = 2,953)		NHI (n = 3,073)		Restricted Ever Māori (n = 3,094)	
	n	%	n	%	n	%	n	%
15-29	7	21.2	8	23.5	6	17.6	8	23.5
30-	87	25.4	75	21.9	79	23.1	82	24.0
35-	223	23.2	197	20.5	203	21.1	208	21.6
40-	476	20.3	403	17.1	436	18.6	419	17.8
45-	706	18.1	618	15.8	642	16.4	648	16.6
50-	759	13.8	664	12.1	704	12.8	698	12.7
55-	797	11.9	674	10.0	724	10.8	697	10.4
60-	842	11.5	707	9.6	782	10.7	729	9.9
65-	716	8.4	601	7.0	624	7.3	635	7.4
70-	500	5.2	403	4.2	417	4.4	426	4.5
75-	306	3.2	235	2.4	240	2.5	254	2.6
80-	182	2.4	138	1.8	142	1.9	151	2.0
85+	85	1.4	63	1.0	65	1.0	67	1.1

Note: age groups 15-29 and 85+ have been grouped together in order to combine low numbers

Ever Māori: 'Māori' on any hospital admission 1988-2004 or death registration 2000-2006
Index Admission: 'Māori' on first hospital admission for acute routine IHD event
NHI: 'Māori' on National Health Index number as at 20 February 2006
Restricted Ever Māori: 'Māori' on any hospital admission from 1988 up to and including first admission for acute routine IHD event between 2000-2004

Figure 4: Proportion of Māori in each five-year age group first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004



Population Rates of IHD

Table 6 shows population rates for first routine acute IHD admissions during the cohort entry time period (2000-2004), using 2001 usually resident population counts as denominator.[xiii] Both crude data and data age-standardised to the 2001 Māori standard population are presented.[xiv] As expected, using different methods to determine ethnicity produces some variation in population rates of ischaemic heart disease hospitalisations for Māori in this time period.

Assigning ethnicity using the ever Māori method produces the largest rate per 100,000 for Māori in both crude and age-standardised data (128.1 using ever Māori). Assigning ethnicity using the restricted ever Māori method produces the next highest rate (117.5) then NHI ethnicity (116.7) and index admission ethnicity (112.2). Age-standardised rates for Māori approximate crude rates as data is standardised to the 2001 Māori standard population.

Crude population rates of IHD for non-Māori change considerably when age-standardised because of the use of the Māori standard population (which has a considerably different age structure than that of the patient cohort). However, in both crude and age-standardised rates there is little variation across the estimates for the different methods used to measure ethnicity. Age standardised rates for non-Māori are 77.1 when using the ever Māori method to measure ethnicity, 78.4 with index admission ethnicity, and 77.9 for both NHI ethnicity and use of restricted ever Māori method.

The denominator for the calculation of Māori population rates is constant for each method of measuring ethnicity (presented in appendix 1). Therefore, the variation seen in age-standardised rates for Māori across the four methods of measuring ethnicity is expected as this changes the numerator (see Figure 5). Similarly, the denominator used in the calculation of non-Māori rates is constant for each of the

---

[xiii] See appendix 1 for denominator data

[xiv] See Appendix 2 for 2001 Māori standard population weights

different methods of measuring ethnicity. There is less variation of non-Māori rates (compared to Māori) across the different methods of measuring ethnicity, due to the smaller proportional change that a change in Māori numbers makes to non-Māori data. A relatively large change in the Māori numerator will still have a comparatively small impact on the non-Māori numerator because it is much bigger than the Māori group.

This might best be illustrated using an example. The total number of patients admitted to hospital for an IHD event during this time was 39,281. Using the ever Māori method, 3,371 of these individuals are measured as Māori ethnicity, and 35,910 as non-Māori. Crude rates are determined as follows using population denominators calculated over the five-year period:

Māori (ever Māori): $\frac{3{,}371}{2{,}631{,}390} \times 100{,}000 = 128.1$

Non-Māori (ever Māori): $\frac{35{,}910}{18{,}686{,}400} \times 100{,}000 = 223.7$

Assigning ethnicity using the restricted ever Māori method, the number of Māori becomes 3,094. Essentially, 277 of the 'Māori' assigned using ever Māori method are re-categorised as 'non-Māori', using the restricted ever Māori method. This number is a bigger proportion of the number of Māori (3,371) than it is of non-Māori (35,910), and will therefore cause a relatively bigger change to the Māori numerator.

Māori (restricted ever Māori): $\frac{3{,}371 - 277}{2{,}631{,}390} \times 100{,}000 = 117.6$

Non-Māori (restricted ever Māori): $\frac{35{,}910 + 277}{18{,}686{,}400} \times 100{,}000 = 225.4$

So, compared to the ever Māori method, using the restricted ever Māori method produces a considerably smaller rate for Māori (117.6 compared to 128.1), but a similar rate for non-Māori (225.4 compared to 223.7).

This variation in the Māori rates is the driver for the variation in Māori:non-Māori rate ratios as seen in table 6. Age-standardised rate ratios range from 1.43 (index admission ethnicity) to 1.66 (ever Māori ethnicity).

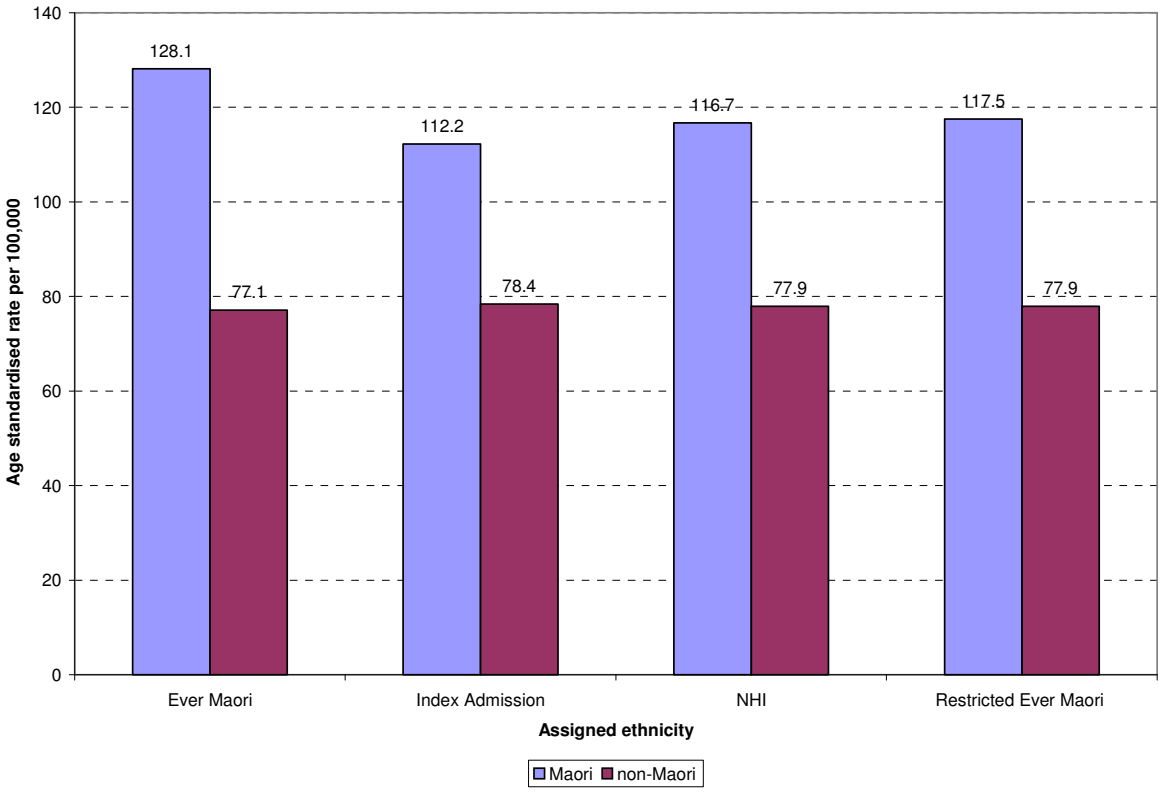
Table 6: Population rates age standardised to 2001 Māori standard population,[xv] patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, using different methods to measure ethnicity

Ethnicity	Māori			Non-Māori			Māori:non-Māori rate ratio	
	n	Crude rate per 100,000	Age-standardised rate per 100,000	n	Crude rate per 100,000	Age-standardised rate per 100,000	Crude rate ratio	Age-standardised rate ratio
Ever Māori	3,371	128.1	128.1	35,910	223.7	77.1	0.57	1.66
Index admission	2,953	112.2	112.2	36,328	226.3	78.4	0.50	1.43
NHI	3,073	116.8	116.7	36,208	225.5	77.9	0.52	1.50
Restricted Ever Māori	3,094	117.6	117.5	36,187	225.4	77.9	0.52	1.51

Note: population denominators are usually resident population counts Census 2001 prioritised ethnicity from Statistics New Zealand. See Appendix 1 for denominator data.

[xv] See Appendix 2 for 2001 Māori population standard weightings

Figure 5: Population rates age standardised to 2001 Māori standard population, patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, using different methods to measure ethnicity



Note: population denominators are usually resident population counts Census 2001 prioritised ethnicity from Statistics New Zealand

Ever Māori:	'Māori' on any hospital admission 1988-2004 or death registration 2000-2006
Index Admission:	'Māori' on first hospital admission for acute routine IHD event
NHI:	'Māori' on National Health Index number as at 20 February 2006
Restricted Ever Māori:	'Māori' on any hospital admission from 1988 up to and including first admission for acute routine IHD event between 2000-2004

Principal Diagnosis

Table 7 provides Māori:non-Māori odds ratios (OR) for principal diagnosis for patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, using different methods to measure ethnicity.

For each principle diagnosis, unadjusted data is not greatly altered when the different methods are used to measure ethnicity. For example, the Māori:non-Māori odds ratio for unspecified myocardial infarction is 0.91 when using the ever Māori method to assign ethnicity, 0.89 using index admission ethnicity, 0.88 using NHI ethnicity and 0.90 when assigning ethnicity using the restricted ever Māori method.

Similarly data adjusted for age and sex shows little variation with the different measures of ethnicity (Figure 6). For example, odds ratios produced for ST-elevated myocardial infarction of sites other than anterior are 0.69, 0.66, 0.69 and 0.65 using ever Māori ethnicity, index admission ethnicity, NHI ethnicity and the restricted ever Māori method to assign ethnicity, respectively. In this cohort, Māori are diagnosed with unspecified myocardial infarction at between 28-31% more than non-Māori dependent on the method used to measure ethnicity.

For other principal diagnoses there is also little or no change in odds ratios when different methods are used to measure ethnicity. One exception is the diagnosis of acute 'other' ischaemic heart disease where adjusted odds ratios produced using the different methods to measure ethnicity ranged from 0.54 to 0.64. However, the numbers of individuals are small in this category (for example; 17 Māori and 341 non-Māori using ever Māori classification) which leads to statistical instability. Confidence intervals are all overlapping.

Although upper and lower limits of confidence intervals vary slightly for each diagnosis with the different methods to measure ethnicity, the level of precision of the odds ratio estimates for both unadjusted and adjusted data is not greatly altered overall.

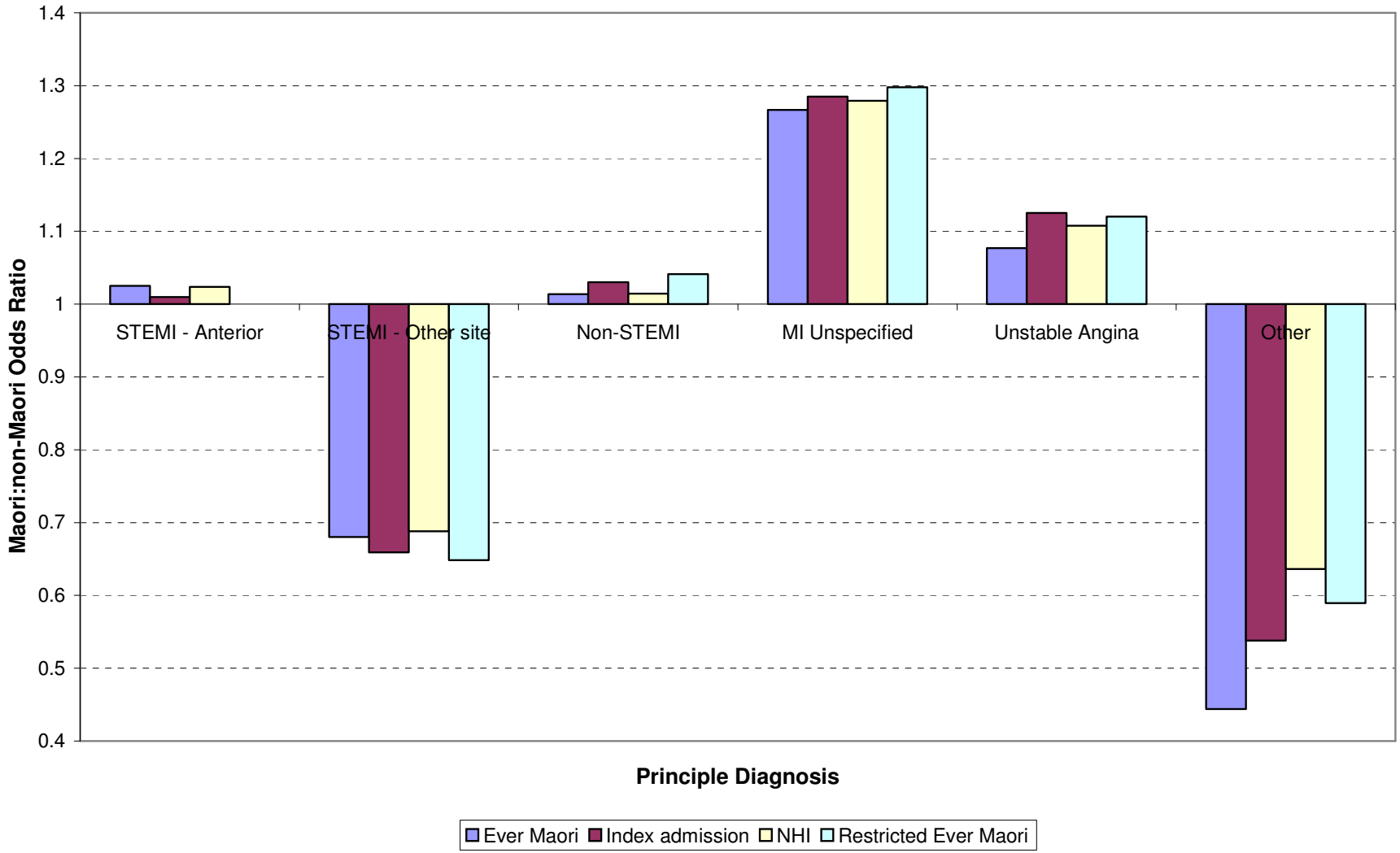
There is some minor variation in p-values for data adjusted for age and sex. The p-value for non-STEMI MI using NHI ethnicity is above 0.05 (p=0.73), whereas using the other methods to measure ethnicity, this value falls below 0.05. Therefore the OR generated using NHI ethnicity would not be considered statistically significant, but again overall findings for this diagnosis using each method of measuring ethnicity would be similar.

Table 7: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, Māori:non-Māori odds ratios for principal diagnosis

Ethnicity	Diagnosis	n Māori	n non-Māori	Unadjusted			Adjusted for age and sex		
				OR	95% CI	p	OR	95% CI	p
Ever Māori n(Māori) = 3,371	STEMI - Anterior	406	4,103	1.06	(0.95–1.18)	0.28	1.03	(0.92–1.15)	0.63
	STEMI - other site	432	5,484	0.82	(0.73–0.91)	0.0001	0.69	(0.62–0.77)	<0.0001
	non STEMI	1,016	11,566	0.91	(0.84–0.98)	0.014	1.03	(0.95–1.11)	0.49
	MI unspecified	361	4,163	0.91	(0.82–1.02)	0.12	1.31	(1.16–1.48)	<0.0001
	unstable angina	1,139	10,253	1.28	(1.18–1.38)	<0.0001	1.08	(1.00–1.17)	0.048
	other	17	341	0.53	(0.32–0.86)	0.011	0.57	(0.35–0.94)	0.026
Index admission n(Māori) = 2,953	STEMI - Anterior	351	4,158	1.04	(0.93–1.17)	0.46	1.01	(0.90–1.14)	0.87
	STEMI - other site	365	5,551	0.78	(0.70–0.88)	<0.0001	0.66	(0.59–0.74)	<0.0001
	non STEMI	889	11,693	0.91	(0.84–0.98)	0.020	1.03	(0.95–1.12)	0.48
	MI unspecified	309	4,215	0.89	(0.79–1.01)	0.062	1.28	(1.13–1.46)	0.0001
	unstable angina	1,025	10,367	1.33	(1.23–1.44)	<0.0001	1.13	(1.04–1.22)	0.005
	other	14	344	0.50	(0.29–0.85)	0.011	0.54	(0.31–0.93)	0.025
NHI n(Māori) = 3,073	STEMI - Anterior	370	4,139	1.06	(0.95–1.19)	0.31	1.02	(0.91–1.15)	0.69
	STEMI - other site	395	5,521	0.82	(0.73–0.91)	0.0004	0.69	(0.62–0.77)	<0.0001
	non STEMI	916	11,666	0.89	(0.82–0.97)	0.006	1.01	(0.93–1.10)	0.73
	MI unspecified	319	4,205	0.88	(0.78–0.99)	0.040	1.28	(1.13–1.45)	0.0001
	unstable angina	1,056	10,336	1.31	(1.21–1.42)	<0.0001	1.11	(1.02–1.20)	0.013
	other	17	341	0.59	(0.36–0.95)	0.032	0.64	(0.39–1.05)	0.075
Restricted Ever Māori n(Māori) = 3,094	STEMI - Anterior	365	4,144	1.03	(0.92–1.16)	0.56	1.00	(0.89–1.12)	1.00
	STEMI - other site	378	5,538	0.77	(0.69–0.86)	<0.0001	0.65	(0.58–0.73)	<0.0001
	non STEMI	938	11,644	0.92	(0.85–0.99)	0.033	1.04	(0.96–1.13)	0.33
	MI unspecified	327	4,197	0.90	(0.80–1.01)	0.085	1.30	(1.15–1.47)	<0.0001
	unstable angina	1,070	10,322	1.32	(1.23–1.43)	<0.0001	1.12	(1.03–1.21)	0.005
	other	16	342	0.54	(0.33–0.90)	0.018	0.59	(0.35–0.98)	0.042

Note: an odds ratio greater than 1.0 indicates that proportionally more Māori than non-Māori have this diagnosis in the cohort

Figure 6: Māori:non-Māori odds ratios for principle diagnosis, adjusted for age, and sex, patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004



Procedure Receipt

Procedures Received During First Admission

Tables 8-11 present Māori:non-Māori hazard ratios (HR) for receipt of cardiac procedures during first admission for patients first admitted to hospital for a routine acute ischaemic heart disease event during 2000-2004.

The data adjusted for age, sex and diagnosis, show that while there is some slight variation in hazard ratios dependent on the method used to measure ethnicity, the overall disparities do not change. For example, the fully adjusted hazard ratio for angioplasty with stenting was 0.80 for ethnicity assigned using either the ever Māori method or restricted ever Māori, and produced a similar value of 0.77 using either NHI ethnicity or ethnicity recorded at index admission.

For data adjusted for age, sex, diagnosis and co-morbidities, the HR for angioplasty without stenting is 0.99, 1.11, 0.95 and 1.15 for ethnicity measured using the ever Māori method, index admission ethnicity, NHI ethnicity and restricted ever Māori method respectively. However, the confidence intervals for these hazard ratios are relatively wide, they overlap, and include the null, therefore conclusions drawn on data for angioplasty without stenting are not likely to differ with the different methods used to measure ethnicity. The variation seen in the hazard ratios and the wide confidence intervals are likely due to small numbers of Māori receiving this procedure (there were 30 Māori and 387 non-Māori using the ever Māori method to assign ethnicity), leading to statistical instability.

Using the restricted ever Māori method to assign ethnicity produces hazard ratios that are higher than those produced using other methods to measure ethnicity for all coronary artery bypass grafts, angioplasty without stenting, and angiocardiography procedures. The restricted ever Māori method also produces hazard ratios that are equivalent to those produced using the ever Māori method for PCI and angioplasty with stenting, as seen in Figure 7. The difference is slight but perceptible, indicating that with the exception of angioplasty without stenting, using the restricted ever

Māori method to assign ethnicity results in slightly conservative estimates of the disparity compared to use of other methods.

Confidence intervals and p-values do not change considerably for either unadjusted or adjusted data, and therefore the use of different methods to measure ethnicity would not affect the reporting of results with respect to chance.

Table 8: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received during first admission – proportional hazard models – EVER MĀORI[xvi]

Procedure n(Māori) = 3,371	n (Māori)	n (non-Māori)	Unadjusted			Adjusted for age, sex, diagnosis			Adjusted for age, sex, diagnosis and co-morbidities		
			HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Angiocardiography / catheterisation	953	10,360	0.99	(0.92–1.05)	0.69	0.80	(0.75–0.86)	<0.0001	0.83	(0.77–0.89)	<0.0001
Angioplasty (PCI)	435	6,020	0.95	(0.86–1.05)	0.29	0.76	(0.69–0.84)	<0.0001	0.80	(0.72–0.88)	<0.0001
- Angioplasty with stenting	417	5,713	0.96	(0.87–1.06)	0.38	0.76	(0.69–0.85)	<0.0001	0.80	(0.72–0.88)	<0.0001
- Angioplasty without stenting	30	387	1.13	(0.78–1.64)	0.51	0.93	(0.64–1.36)	0.72	0.99	(0.68–1.45)	0.97
Coronary artery bypass (CABG)	129	1,496	1.08	(0.90–1.30)	0.38	0.92	(0.76–1.10)	0.36	0.94	(0.78–1.13)	0.49
- Coronary artery bypass mammary artery graft	115	1,380	1.08	(0.89–1.30)	0.44	0.89	(0.73–1.08)	0.25	0.89	(0.73–1.09)	0.26
- Coronary artery bypass other grafts	125	1,457	1.07	(0.89–1.29)	0.46	0.91	(0.76–1.10)	0.34	0.93	(0.77–1.12)	0.46

Note: Hazard ratio less than 1.0 indicates Māori less likely to receive this procedure during the time period of this study

Table 9: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received during first admission – proportional hazard models –INDEX ADMISSION

Procedure n(Māori) = 2,953	n (Māori)	n (non-Māori)	Unadjusted			Adjusted for age, sex, diagnosis			Adjusted for age, sex, diagnosis and co-morbidities		
			HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Angiocardiography / catheterisation	820	10,493	0.97	(0.91–1.05)	0.46	0.79	(0.73–0.85)	<0.0001	0.82	(0.76–0.88)	<0.0001
Angioplasty (PCI)	363	6,092	0.92	(0.83–1.02)	0.13	0.74	(0.66–0.82)	<0.0001	0.78	(0.70–0.86)	<0.0001
- Angioplasty with stenting	346	5,824	0.92	(0.83–1.03)	0.15	0.74	(0.66–0.83)	<0.0001	0.77	(0.69–0.86)	<0.0001
- Angioplasty without stenting	28	389	1.25	(0.85–1.83)	0.25	1.04	(0.70–1.53)	0.86	1.11	(0.75–1.65)	0.60
Coronary artery bypass (CABG)	116	1,509	1.11	(0.92–1.35)	0.26	0.93	(0.77–1.13)	0.46	0.95	(0.78–1.15)	0.60
- Coronary artery bypass mammary artery graft	104	1,391	1.12	(0.92–1.37)	0.25	0.92	(0.75–1.12)	0.39	0.91	(0.74–1.12)	0.38
- Coronary artery bypass other grafts	112	1,270	1.10	(0.91–1.33)	0.34	0.92	(0.76–1.12)	0.41	0.94	(0.77–1.15)	0.54

Note: Hazard ratio less than 1.0 indicates Māori less likely to receive this procedure during the time period of this study

[xvi] These tables are for procedures received during the first hospital admission or transfer for an ischaemic heart disease event, and adjusted for co-morbidities secondary on the index admission (first with IHD diagnosis)

Table 10: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received during first admission – proportional hazard models – NHI

Procedure n(Māori) = 3,073	n (Māori)	n (non-Māori)	Unadjusted			Adjusted for age, sex, diagnosis			Adjusted for age, sex, diagnosis and co-morbidities		
			HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Angiocardiography / catheterisation	874	10,439	0.98	(0.91–1.05)	0.50	0.79	(0.73–0.84)	<0.0001	0.81	(0.75–0.87)	<0.0001
Angioplasty (PCI)	394	6,061	0.92	(0.83–1.02)	0.13	0.74	(0.66–0.82)	<0.0001	0.76	(0.69–0.85)	<0.0001
- Angioplasty with stenting	378	5,792	0.93	(0.84–1.03)	0.18	0.74	(0.67–0.82)	<0.0001	0.77	(0.69–0.85)	<0.0001
- Angioplasty without stenting	27	390	1.10	(0.74–1.62)	0.65	0.89	(0.60–1.33)	0.58	0.95	(0.63–1.41)	0.78
Coronary artery bypass (CABG)	118	1,507	1.08	(0.89–1.30)	0.42	0.89	(0.73–1.08)	0.23	0.91	(0.75–1.10)	0.32
- Coronary artery bypass mammary artery graft	106	1,389	1.09	(0.89–1.33)	0.40	0.87	(0.71–1.07)	0.19	0.87	(0.71–1.07)	0.18
- Coronary artery bypass other grafts	114	1,468	1.06	(0.88–1.29)	0.52	0.88	(0.73–1.07)	0.21	0.90	(0.74–1.09)	0.28

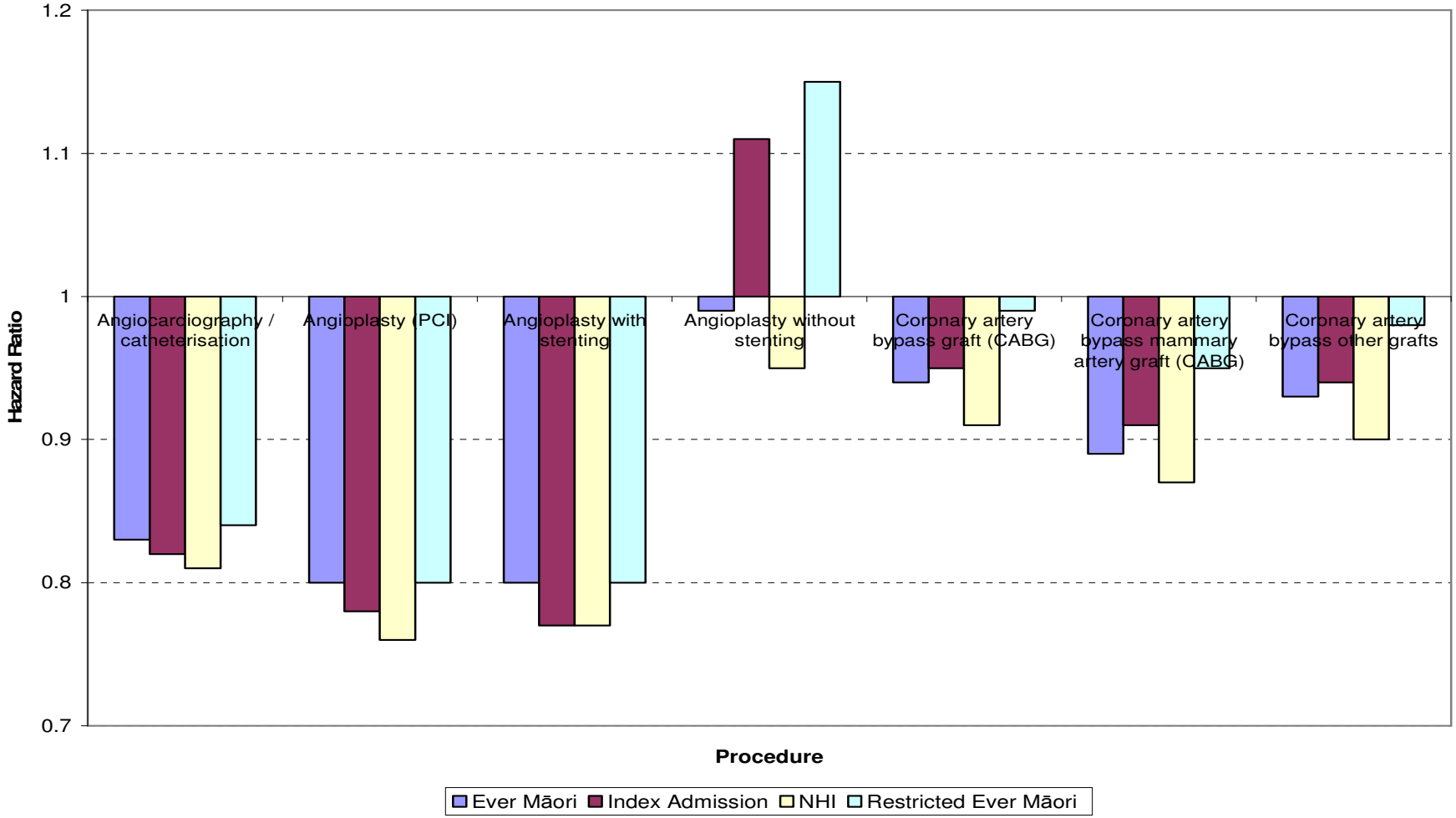
Note: Hazard ratio less than 1.0 indicates Māori less likely to receive this procedure during the time period of this study

Table 11: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received during first admission – proportional hazard models – RESTRICTED EVER MĀORI

Procedure n(Māori) = 3,094	n (Māori)	n (non-Māori)	Unadjusted			Adjusted for age, sex, diagnosis			Adjusted for age, sex, diagnosis and co-morbidities		
			HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Angiocardiography / catheterisation	870	10,443	1.00	(0.93–1.07)	0.93	0.81	(0.75–0.87)	<0.0001	0.84	(0.78–0.90)	<0.0001
Angioplasty (PCI)	384	6,071	0.95	(0.86–1.05)	0.34	0.76	(0.69–0.85)	<0.0001	0.80	(0.72–0.89)	<0.0001
- Angioplasty with stenting	367	5,803	0.96	(0.86–1.06)	0.41	0.77	(0.69–0.85)	<0.0001	0.80	(0.72–0.89)	<0.0001
- Angioplasty without stenting	29	388	1.28	(0.88–1.87)	0.19	1.06	(0.73–1.56)	0.75	1.15	(0.78–1.69)	0.49
Coronary artery bypass (CABG)	124	1,501	1.16	(0.96–1.39)	0.12	0.97	(0.80–1.17)	0.73	0.99	(0.82–1.19)	0.89
- Coronary artery bypass mammary artery graft	111	1,384	1.16	(0.96–1.41)	0.13	0.95	(0.78–1.16)	0.60	0.95	(0.77–1.16)	0.58
- Coronary artery bypass other grafts	120	1,492	1.14	(0.95–1.38)	0.16	0.96	(0.79–1.16)	0.68	0.98	(0.81–1.19)	0.83

Note: Hazard ratio less than 1.0 indicates Māori less likely to receive this procedure during the time period of this study

Figure 7. Procedures received during first admission, Māori:non-Māori hazard ratios, adjusted for age and sex, diagnosis and co-morbidities, using different methods to measure ethnicity



Procedures Received any time after Admission

Tables 12-15 provide Māori:non-Māori hazard ratios, confidence intervals and p-values for treatment procedures received any time after first hospital admission for an IHD event. In both adjusted and unadjusted data there is slight variation of hazard ratios with use of the different methods of measuring ethnicity, however the direction of the disparity does not change.

Comparing data adjusted for age, sex and diagnosis with data adjusted for age, sex, diagnosis *and co-morbidities*, using the ever Māori method to assign ethnicity, adjusting for co-morbidities decreases the disparity slightly for angiocardiography receipt and PCI, and increases the disparity slightly for CABG. This pattern remains the same regardless of the method used to measure ethnicity. Any differences are slight and the confidence intervals overlapping, indicating that the difference in Māori:non-Māori hazard ratios produced when different methods are used to measure ethnicity would not lead to a different interpretation of the results.

Figure 8 shows the slight variation in hazard ratios produced when using different methods to measure ethnicity. The ever Māori method consistently produces slightly higher hazard ratios in comparison to the other methods, therefore slightly more conservative estimates of the disparity.

While upper and lower limits of confidence intervals change slightly with the use of different methods to measure ethnicity, the significance of the hazard ratio estimates does not change.

There is some slight variation in p-values for the hazard ratios. Those for 'coronary artery bypass other grafts' adjusted for all factors occur either side of 0.05 with use of different methods to assign ethnicity. For example this value is 0.11 using either ever Māori or NHI ethnicity, 0.052 using index admission ethnicity and 0.035 using restricted ever Māori. This variation could affect the interpretation of results with respect to chance. However, the overall interpretation of the results is unlikely to change.

Comparing data for procedures received during first hospital admission with procedures received any time *after* admission, adjusted for age, sex, diagnosis and co-morbidities, it would appear that use of the restricted ever Māori method to assign ethnicity produces the most conservative estimate of the disparity for all procedures received during first admission (with the exception of angioplasty without stenting), and use of the ever Māori method produces the most conservative estimate of the disparity for all procedures received any time after admission, in comparison to other methods used to measure ethnicity in this cohort. The difference is slight but relatively consistent, and can be seen when comparing figures 7 and 8. However, the overall patterns change very little with the different methods of measuring ethnicity and would not impact on the overall interpretation of findings.

Table 12: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received any time after admission – proportional hazard models – EVER MĀORI

Procedure n(Māori) = 3,371	n (Māori)	n (non-Māori)	Unadjusted			Adjusted for age, sex, diagnosis			Adjusted for age, sex, diagnosis and co-morbidities		
			HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Angiocardiography / catheterisation	1,601	15,667	1.05	(1.00–1.11)	0.049	0.71	(0.67–0.75)	<0.0001	0.75	(0.71–0.79)	<0.0001
Angioplasty (PCI)	650	8,366	0.79	(0.73–0.86)	<0.0001	0.56	(0.52–0.61)	<0.0001	0.61	(0.56–0.66)	<0.0001
- Angioplasty with stenting	618	7,885	0.80	(0.74–0.87)	<0.0001	0.57	(0.52–0.62)	<0.0001	0.61	(0.56–0.67)	<0.0001
- Angioplasty without stenting	62	880	0.78	(0.60–1.01)	0.057	0.60	(0.46–0.77)	0.0001	0.65	(0.50–0.85)	0.002
Coronary artery bypass (CABG)	373	3,689	1.06	(0.95–1.18)	0.29	0.95	(0.85–1.06)	0.33	0.91	(0.81–1.02)	0.095
- Coronary artery bypass mammary artery graft	338	3,322	1.07	(0.96–1.20)	0.23	0.95	(0.85–1.06)	0.38	0.92	(0.81–1.03)	0.14
- Coronary artery bypass other grafts	362	3,571	1.06	(0.95–1.19)	0.27	0.96	(0.86–1.07)	0.43	0.91	(0.81–1.02)	0.11

Note: Hazard ratio less than 1.0 indicates Māori less likely to receive this procedure during the time period of this study

Table 13: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received any time after admission – proportional hazard models - INDEX ADMISSION

Procedure n(Māori) = 2,956	n (Māori)	n (non-Māori)	Unadjusted			Adjusted for age, sex, diagnosis			Adjusted for age, sex, diagnosis and co-morbidities		
			HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Angiocardiography / catheterisation	1,365	15,903	1.01	(0.95–1.06)	0.84	0.68	(0.64–0.72)	<0.0001	0.71	(0.67–0.75)	<0.0001
Angioplasty (PCI)	539	8,477	0.74	(0.68–0.81)	<0.0001	0.53	(0.48–0.58)	<0.0001	0.57	(0.52–0.63)	<0.0001
- Angioplasty with stenting	510	7,993	0.75	(0.68–0.82)	<0.0001	0.53	(0.48–0.58)	<0.0001	0.57	(0.52–0.63)	<0.0001
- Angioplasty without stenting	52	890	0.74	(0.56–0.98)	0.037	0.57	(0.43–0.76)	0.0001	0.63	(0.47–0.83)	0.001
Coronary artery bypass (CABG)	318	3,744	1.03	(0.92–1.16)	0.59	0.92	(0.82–1.04)	0.19	0.88	(0.78–1.00)	0.042
- Coronary artery bypass mammary artery graft	289	3,371	1.04	(0.93–1.18)	0.48	0.93	(0.82–1.05)	0.21	0.89	(0.79–1.01)	0.066
- Coronary artery bypass other grafts	310	3,623	1.04	(0.92–1.17)	0.52	0.93	(0.83–1.05)	0.27	0.89	(0.79–1.00)	0.052

Note: Hazard ratio less than 1.0 indicates Māori less likely to receive this procedure during the time period of this study

Table 14: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received any time after admission – proportional hazard models – NHI

Procedure n(Māori) = 3,073	n (Māori)	n (non-Māori)	Unadjusted			Adjusted for age, sex, diagnosis			Adjusted for age, sex, diagnosis and co-morbidities		
			HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Angiocardiography / catheterisation	1,465	15,803	1.05	(1.00–1.11)	0.065	0.70	(0.67–0.74)	<0.0001	0.74	(0.70–0.78)	<0.0001
Angioplasty (PCI)	592	8,424	0.79	(0.73–0.86)	<0.0001	0.55	(0.51–0.60)	<0.0001	0.60	(0.55–0.65)	<0.0001
- Angioplasty with stenting	563	7,940	0.80	(0.73–0.87)	<0.0001	0.56	(0.51–0.61)	<0.0001	0.60	(0.55–0.66)	<0.0001
- Angioplasty without stenting	56	886	0.77	(0.58–1.00)	0.054	0.58	(0.44–0.77)	0.0001	0.63	(0.48–0.84)	0.001
Coronary artery bypass (CABG)	343	3,719	1.06	(0.95–1.19)	0.27	0.95	(0.85–1.06)	0.35	0.91	(0.81–1.02)	0.11
- Coronary artery bypass mammary artery graft	313	3,347	1.08	(0.96–1.21)	0.20	0.95	(0.85–1.07)	0.42	0.92	(0.81–1.04)	0.17
- Coronary artery bypass other grafts	332	3,601	1.07	(0.95–1.19)	0.27	0.95	(0.85–1.07)	0.42	0.91	(0.81–1.02)	0.11

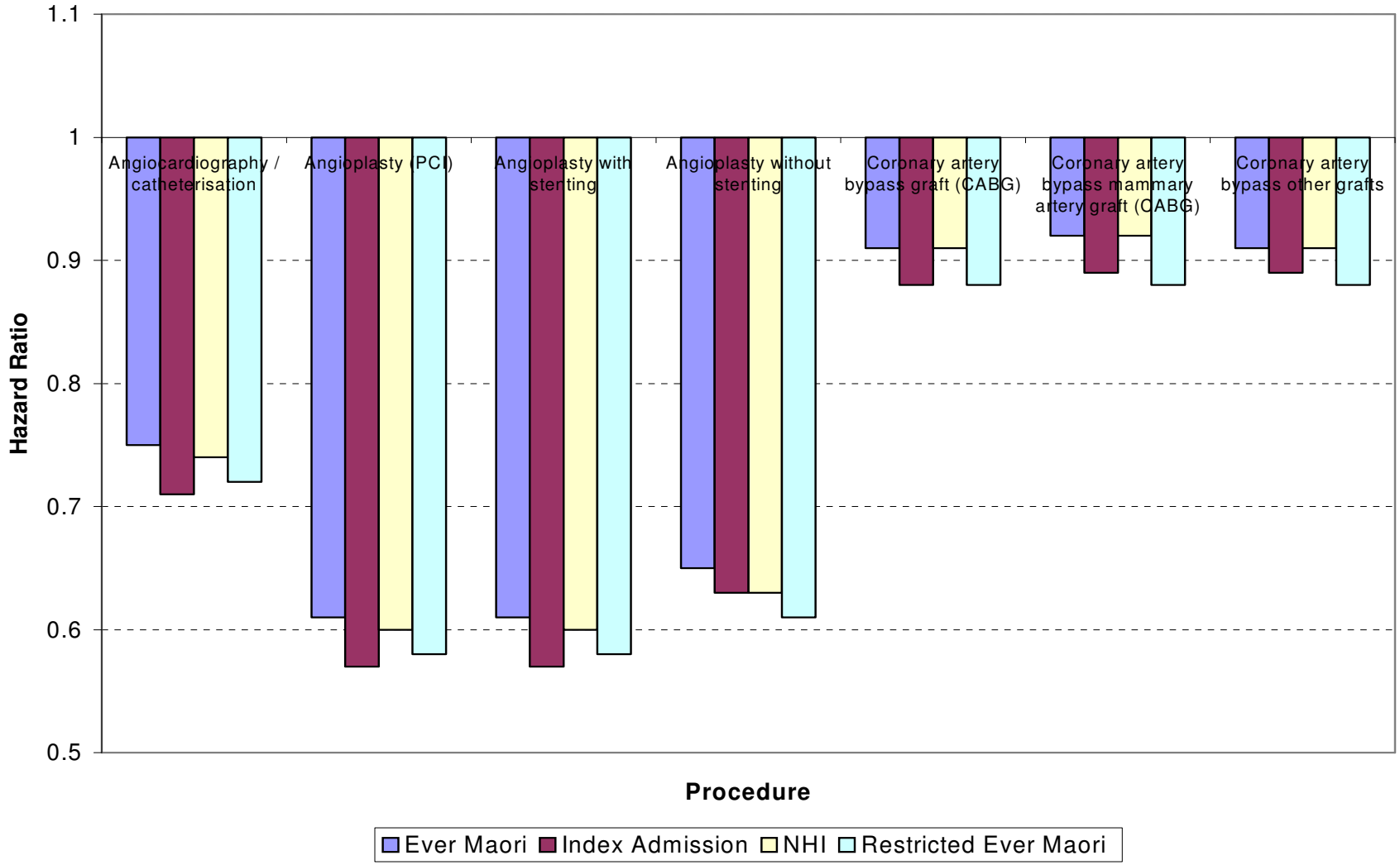
Note: Hazard ratio less than 1.0 indicates Māori less likely to receive this procedure during the time period of this study

Table 15: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, procedures received any time after admission – proportional hazard models – RESTRICTED EVER MĀORI

Procedure n(Māori) = 3,094	n (Māori)	n (non-Māori)	Unadjusted			Adjusted for age, sex, diagnosis			Adjusted for age, sex, diagnosis and co-morbidities		
			HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Angiocardiography / catheterisation	1,442	15,826	1.02	(0.96–1.08)	0.51	0.68	(0.65–0.72)	<0.0001	0.72	(0.68–0.76)	<0.0001
Angioplasty (PCI)	567	8,449	0.75	(0.69–0.81)	<0.0001	0.53	(0.49–0.58)	<0.0001	0.58	(0.53–0.63)	<0.0001
- Angioplasty with stenting	538	7,965	0.75	(0.69–0.82)	<0.0001	0.53	(0.49–0.58)	<0.0001	0.58	(0.53–0.63)	<0.0001
- Angioplasty without stenting	53	889	0.72	(0.55–0.95)	0.021	0.55	(0.42–0.73)	<0.0001	0.61	(0.46–0.81)	0.0006
Coronary artery bypass (CABG)	333	3,729	1.02	(0.91–1.15)	0.68	0.92	(0.82–1.03)	0.13	0.88	(0.78–0.98)	0.027
- Coronary artery bypass mammary artery graft	300	3,360	1.03	(0.92–1.16)	0.61	0.91	(0.81–1.03)	0.14	0.88	(0.78–0.99)	0.037
- Coronary artery bypass other grafts	324	3,609	1.03	(0.92–1.16)	0.59	0.93	(0.82–1.04)	0.20	0.88	(0.78–0.99)	0.035

Note: Hazard ratio less than 1.0 indicates Māori less likely to receive this procedure during the time period of this study

Figure 8. Procedures received any time after admission, Māori:non-Māori hazard ratios, adjusted for age and sex, diagnosis and co-morbidities, using different methods to measure ethnicity



Mortality

Table 16 presents mortality data on deaths any time following admission for a first routine acute IHD event, using mortality data up to 31 December 2006.

Māori:non-Māori mortality hazard ratios for death from ischaemic heart disease are systematically higher when using the ever Māori method to assign ethnicity, for both adjusted (HR = 1.88 for ever Māori adjusted for age, sex and diagnosis and 1.79, 1.73 and 1.81 with use of index admission, NHI and restricted ever Māori respectively) and unadjusted (HR = 0.81 for ever Māori and 0.75, 0.72 and 0.77 with use of index admission, NHI and restricted ever Māori respectively) data. This can be seen in Figure 9. Overall, using the ever Māori method produces the least conservative estimate of the disparity in deaths from IHD between Māori and non-Māori in this cohort.

A similar yet less consistent pattern is seen when mortality data is stratified by principle diagnosis (Table 15, Figure 8). Māori:non-Māori mortality hazard ratios for those diagnosed with myocardial infarction (either ST-elevated or unspecified) are least conservative when ethnicity is measured using the ever Māori method, compared to other methods. For example, for unspecified myocardial infarction, the hazard ratio is 1.51 when using the ever Māori method to assign ethnicity, but has a value of only 1.36 when using index admission ethnicity, 1.34 using NHI ethnicity and 1.36 when assigning ethnicity using the restricted ever Māori method.

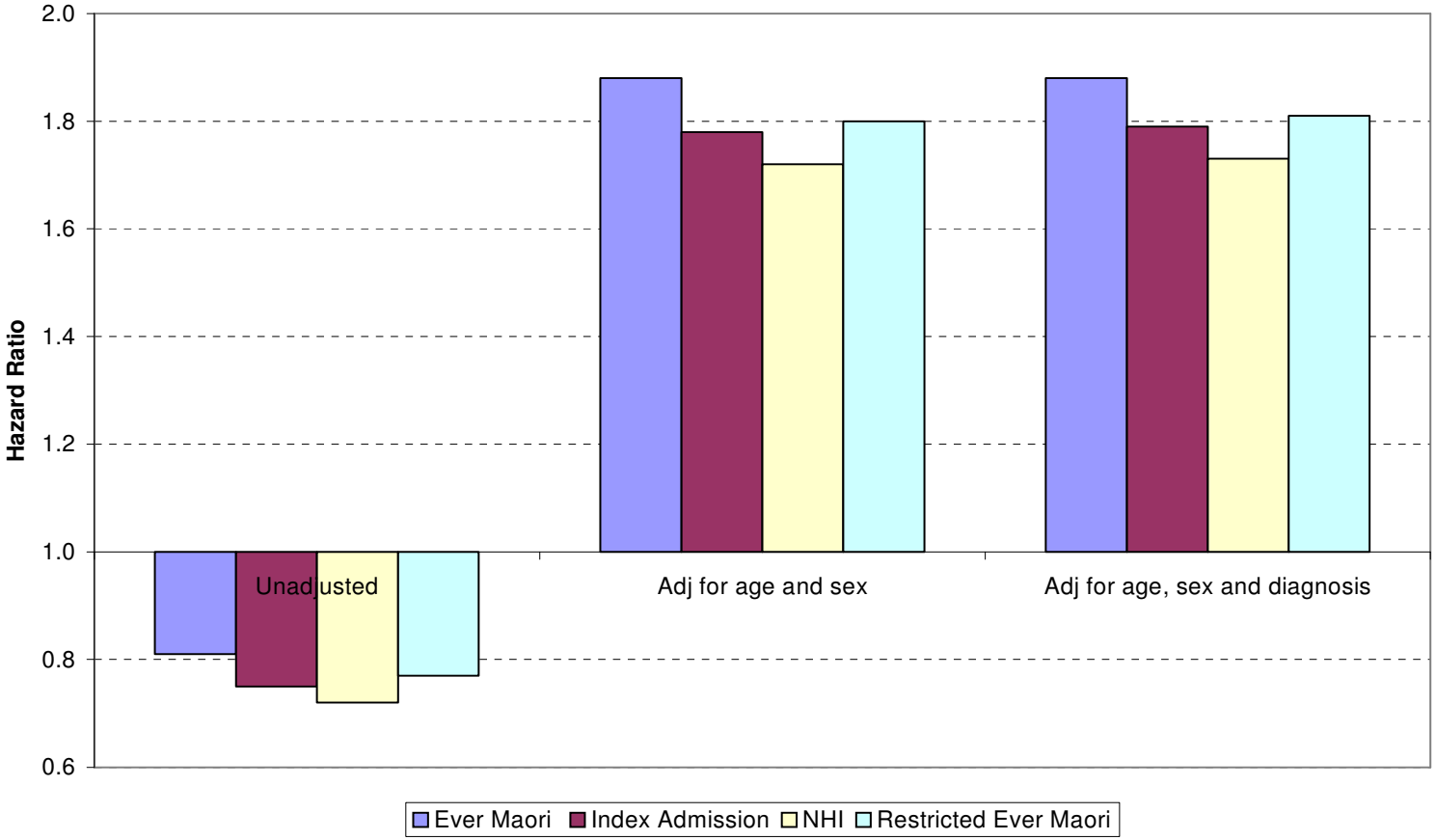
A systematic difference in Māori:non-Māori hazard ratios for other principle diagnoses, generated using the different methods to measure ethnicity is not obvious.

Table 16: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004 – deaths from IHD any time following admission. Proportional hazards model (deaths up to 31 December 2006), using different methods to measure ethnicity

Mortality		Ever Māori n(Māori) = 3,371			Index Admission n(Māori) = 2,953			NHI n(Māori)= 3,073			Restricted Ever Māori n(Māori)= 3,094		
		HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value	HR	95% CI	p-value
Māori:non-Māori death from IHD	Unadjusted	0.81	(0.72–0.92)	0.0006	0.75	(0.66–0.86)	<0.0001	0.72	(0.64–0.82)	<0.0001	0.77	(0.67–0.87)	<0.0001
	Adj for age and sex	1.88	(1.67–2.12)	<0.0001	1.78	(1.56–2.03)	<0.0001	1.72	(1.50–1.96)	<0.0001	1.80	(1.58–2.04)	<0.0001
	Adj for age, sex and diagnosis	1.88	(1.67–2.12)	<0.0001	1.79	(1.57–2.04)	<0.0001	1.73	(1.52–1.98)	<0.0001	1.81	(1.59–2.06)	<0.0001
By diagnosis adjusted for age and sex	MI unspecified	1.51	(1.17–1.96)	0.002	1.36	(1.02–1.83)	0.039	1.34	(1.00–1.79)	0.052	1.36	(1.02–1.81)	0.035
	STEMI - Anterior	1.90	(1.44–2.50)	<0.0001	1.70	(1.25–2.30)	0.0007	1.68	(1.24–2.28)	0.0008	1.70	(1.27–2.29)	0.0004
	STEMI - other site	2.04	(1.51–2.75)	<0.0001	1.91	(1.37–2.65)	0.0001	1.88	(1.36–2.61)	0.0002	1.92	(1.39–2.66)	<0.0001
	non STEMI	1.73	(1.36–2.20)	<0.0001	1.73	(1.33–2.24)	<0.0001	1.61	(1.23–2.09)	0.0004	1.77	(1.38–2.27)	<0.0001
	unstable angina	2.75	(2.03–3.74)	<0.0001	2.80	(2.03–3.88)	<0.0001	2.70	(1.96–3.72)	<0.0001	2.83	(2.07–3.88)	<0.0001
	other	4.55	(1.05–19.76)	0.043	4.80	(1.11–20.74)	0.036	4.55	(1.05–19.76)	0.043	4.59	(1.06–19.93)	0.042

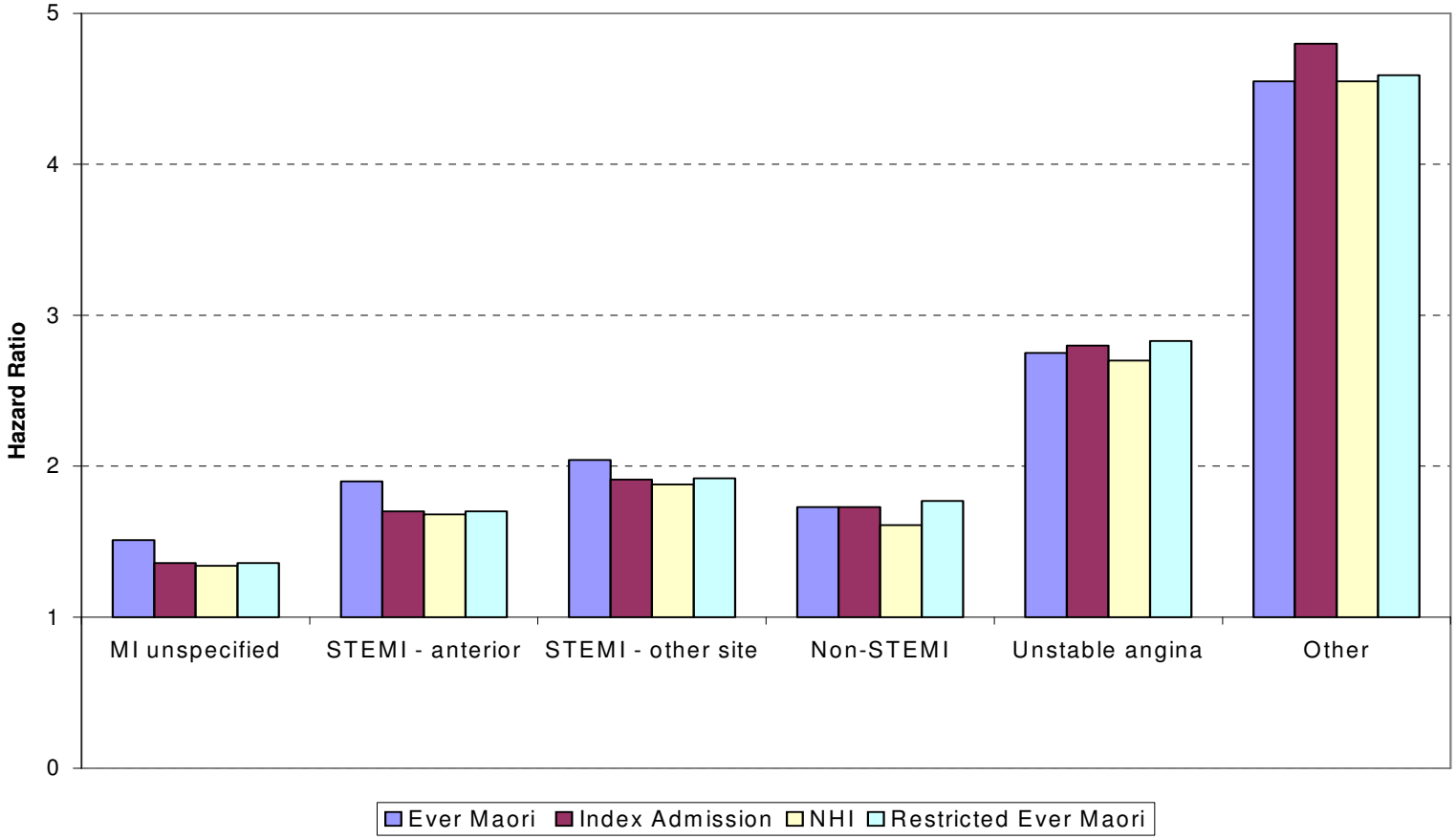
Note: Cause of death is only known for deaths before 31/12/2006. Censoring at the first of 31/12/06 or death. A hazard ratio greater than 1.0 indicates a greater risk of death from IHD any time following admission for Māori

Figure 9: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, deaths from IHD any time following admission up to 31 December 2006. Proportional hazards model, Māori:non-Māori hazard ratios; unadjusted, adjusted for age to 2001 Māori standard population, and sex, and adjusted for age, sex and diagnosis, using different methods to measure ethnicity



Ever Māori:	'Māori' on any hospital admission 1988-2004 or death registration 2000-2006
Index Admission:	'Māori' on first hospital admission for acute routine IHD event
NHI:	'Māori' on National Health Index number as at 20 February 2006
Restricted Ever Māori:	'Māori' on any hospital admission from 1988 up to and including first admission for acute routine IHD event between 2000-2004

Figure 10: Patients first admitted to hospital for a routine acute ischaemic heart disease event 2000-2004, deaths from IHD any time following admission up to 31 December 2006. Proportional hazards model, hazard ratios by diagnosis adjusted for age to 2001 Māori standard population, and sex, using different methods to measure ethnicity



DISCUSSION

Epidemiological data has a crucial role in health, as it informs policy and decision-making and determines resource allocation. By making comparisons of health data for the Māori ethnic group with those who do not identify as Māori, patterns of disparity and privilege can be revealed. The quality of the ethnicity data to inform these comparisons is therefore of extreme importance.

The dynamic nature of ethnicity means that it is challenging to measure. Ethnicity is a value-laden social construct, and as such can change in response to changes in society. Individuals can, and do, alter their ethnicity over time, and in different contexts, and may self-select multiple ethnic groups to identify with. While New Zealand has, in comparison with other countries, relatively good quality ethnicity data, there is an established history of undercounting of Māori in health datasets (Blakely, 2002b; Blakely et al., 2008; Harris et al., 2000; Harris et al., 1997; Robson et al., 1996; Shaw, Atkinson, & Blakely, 2009). The persistent under-enumeration of tangata whenua has led to speculation that there may be implicit acceptance of practices in the health system that continues to overcount the numerically dominant ethnic group at the expense of others (Shaw, Atkinson, & Blakely, 2009). While it appears there may have been improvements in the quality of ethnicity data in recent years (Harris, Purdie et al., 2007), there should remain a concerted focus on improvement.

There are various methods by which ethnicity can be determined in a study. The basis of this dissertation is a sensitivity analysis. Four different methods of measuring ethnicity have been 'tested' to examine their effect on results in the 'Unequal Treatment' cohort study which seeks to determine the extent of disparities in procedure receipt and mortality between Māori and non-Māori with ischaemic heart disease.

It is intended that this analysis will further inform the research team of the nature of the methods used to measure ethnicity, allowing a deeper understanding of the results and providing data that may inform decisions on future analyses in the Unequal Treatment study (Te Rōpū Rangahau Hauora a Eru Pōmare, 2008). Having a range of results available by different ethnicity measures can be useful in justifying or even defending the use of a chosen method to determine ethnicity.

Overall Findings

As expected in this study, it was found that the four different methods used to measure ethnicity produced very similar results with regards to features of the different cohorts defined, odds ratios, and hazard ratios for receipt of procedures for IHD, and death from this disease. While there were some slight systematic differences observed, overall, it is likely to matter very little which method is ultimately chosen to measure ethnicity in future analyses of the Unequal Treatment project. The reasons for the similarity in the results, the reasons for the small differences that were observed, a discussion on the strengths and weaknesses of this particular study, and a more in-depth discussion on the choice of method to use for future analyses are provided below

While a sensitivity analysis within a cohort study has not appeared in the literature, there are studies which have analysed the impact of different ethnicity measures on population rates (Curtis E, 2005). Population census counts are often used as data for denominators in the calculation of population rates. The undercounting of Māori in health datasets that are commonly used as a source of numerator data (such as hospitalisations and cancer registrations) creates a numerator-denominator differential misclassification bias. By way of demonstration, population rates of ischaemic heart disease over the time period of this cohort (2000-2004) were calculated. The denominator was constant for both Māori and non-Māori over each of the four methods used to measure ethnicity, and taken from census mid-year population estimates for this time period using prioritised ethnicity. Therefore, the variation in counts of Māori for hospitalisation data produced with each of the four different methods used to measure ethnicity, created the variation seen in the population rates.

Numerator-denominator ethnicity misclassification bias cannot occur with a cohort study such as the one upon which this dissertation is based, where the denominator groups are internal to the study itself. While each of the methods used to measure ethnicity may have measurement errors, these occur in both the numerator and denominator of the ethnic groups for comparison. Ethnicity data are gathered, stored and processed using the same methods for both groups being compared: Māori and non-Māori.

In this study it was hypothesised that a substantial difference in numbers and characteristics of Māori derived with each method used to measure ethnicity in this study would be required in order to produce results that differ. A change in numbers of one group will affect the numbers of the other group. Proportionally this will affect the Māori group to a greater degree, as this group is numerically smaller than the non-Māori group. The numbers of Māori defined by the different ethnicity measures used in each of the four cohorts varied only slightly, ranging from 2,953 (7.5%) to 3,371 (8.6%) and this was not enough to produce any substantial variation in the study results. Therefore the hypothesis was largely confirmed, as there was little overall difference in results for likelihood of procedure receipt. While the strength of association, the precision of the estimates and the power to detect a difference varied slightly with use of different methods to measure ethnicity, the overall interpretation of the results would be unlikely to change.

Although the results were very similar, there were some slight systematic differences observed with respect to either sample size or by possibly defining cohorts with slightly different characteristics. Possible reasons for these findings are explored below.

Ever Māori was used in the original Unequal Treatment ischaemic heart disease study (Te Rōpū Rangahau Hauora a Eru Pōmare, 2007). This method has been favoured in the past in Kaupapa Māori based research as it maximises the study power for the Māori group and counts all those who have ever been identified as Māori, therefore meeting the right of Māori to be counted. However, in recent years of use it appears it may overestimate the numbers of Māori (Harris, Purdie et al.,

2007). In this study, using the ever Māori method produced the highest number of Māori in the cohort (3,371).

This was also not unexpected as this method uses data over a relatively long period of time – hospitalisation data from 1988 to 2004 and mortality data from 2000 to 2006. Data taken over a longer time period increases the chance of an encounter with the health system (or death) and therefore increases the probability of being classified (or mis-classified) as Māori. For similar reasons, the restricted ever Māori method produced the next highest number of Māori, although less than the number produced using ever Māori as hospitalisation data following admission wasn't used and neither was mortality data. It is expected that an individual, once diagnosed with IHD, will undergo further encounters with the health system (and possibly death) and by not using this data to assign Māori ethnicity, it was hypothesised and confirmed that the count of Māori in the cohort will be lower with the use of the restricted ever Māori method compared to the ever Māori method.

It was also hypothesised that the cohort of Māori identified using the restricted ever Māori method would be less unwell than those produced using ever Māori, therefore lower risk of mortality and lower levels of procedure receipt would be seen for the restricted ever Māori group. The expected pattern wasn't observed with procedures received during admission, however the pattern was just discernible with procedures received any time following admission.

These two different methods (ever Māori and restricted ever Māori) did not appear to identify groups of Māori that were substantially different in terms of demographic and clinical characteristics. The slight variations seen in age structure, primary diagnosis, co-morbidities and proportion of male or female in each group of Māori could be considered unimportant in most circumstances.

Similarly, results of the study did not substantially differ with use of either index admission or NHI ethnicity. The slightly larger number of Māori generated with use of NHI ethnicity compared to index admission ethnicity did not greatly impact either the characteristics of the group of Māori defined (by age, sex, distribution of co-

morbidities or principle diagnoses) or the results for either likelihood of procedure receipt or mortality.

Strengths and Weaknesses of this Study

When an individual is admitted to hospital care, they are required to complete a form that collects ethnicity data (ideally) using a standardised ethnicity question which is in line with the census question (Ministry of Health, 2004a). This study used ethnicity recorded at the time of an individual's first admission for ischaemic heart disease (index admission) as one of the methods to measure ethnicity. The accuracy of ethnicity data collected by this method is subject to the protocols and practices of the hospital and the context in which ethnicity data is obtained. Appropriate collection of ethnicity data may also be compromised depending on the condition of the patient who may be too unwell to self-identify and it is left to a family member, friend or perhaps hospital staff member to complete the ethnicity field on the admission forms. Each encounter an individual has with the health system is recorded on the National Health Index, attached to the person's (encrypted) unique identifier. Therefore, NHI ethnicity can be expected to be as accurate as that recorded on the individual's most recent encounter with the health system.

All the methods used to measure ethnicity in this study are subject to the accuracy of ethnicity data collection, storage and processing, however undercounting of Māori is likely to affect the NHI and index admission methods more than the two methods which involve the reassignment of ethnicity. For the ever Māori and restricted ever Māori method, ethnicity is determined over a period of time therefore increasing the chance that a Māori individual is classified as Māori in the cohort.

From the outset of this study, there was no preferred method for measuring ethnicity. Not having a 'gold standard' made even the discussion of study results difficult. 'Misclassification' of ethnicity implies an ideal source of ethnicity data from which to 'misclassify' in comparison, and 'undercount' assumes a trusted source of ethnicity data from which to undercount from. Previous to the time period of this research (2000-2004), a Kaupapa Māori-focussed study might have advocated for the use of the ever Māori method as it maximises the count of Māori and allows all individuals

who have ever been classified as Māori to be recognised as such in the data. This method assumes the undercount of Māori that has been evident in historical data. However, as data quality improves and more years of data are used to assign ever Māori, recent analyses appears to show that ever Māori may overcount Māori (Harris, Purdie et al., 2007). The danger of overcounting, where a number of non-Māori have been mis-classified as Māori, is that any differences or disparities will be 'diluted' and likely biased towards the null, as the resulting Māori data will essentially include non-Māori data. With an improvement of ethnicity data quality, the ever Māori method will become increasingly redundant, and only be applicable for use with the time periods of data with known undercount. Adjusting for undercount may be more important in the calculation of population rates when a numerator-denominator bias exists, and these adjusters might be more appropriate for use in recent time periods where the ever Māori method appears to overcount.

The degree to which the ever Māori method may compensate for undercount, or lead to an overcount, is generally not known in a study and would vary with the length of time over which data is used to assign ethnicity.

A possible issue with use of the ever Māori method as it is defined in this study, is that the distinction between exposure (ethnicity) and outcome (death) is somewhat blurred. Mortality data is used to assign ethnicity to individuals in the cohort using the ever Māori method. Therefore, ethnicity is being assigned using ethnicity on an outcome variable of interest, ie; death. This may have biased the results towards higher levels of mortality for Māori. Previous studies have shown that among patients with ischaemic heart disease, Māori are at greater risk of mortality (Westbrooke et al., 2001). In this study, the ever Māori method produced the least conservative estimate of mortality, showing the greatest disparity. The difference from the other methods was slight but perceptible.

A difference is seen with the use of the restricted ever Māori method which did not use mortality data, and also did not produce an estimate of mortality disparity as high as that produced using the ever Māori method. In addition, using the restricted ever Māori method, ethnicity was not assigned using hospital data subsequent to initial diagnosis so there is less chance of an individual being assigned Māori ethnicity in

the cohort. Following diagnosis it is likely that an IHD patient will experience further encounters with the hospital system, and this increases their likelihood of being assigned Māori ethnicity if this data is used.

A key feature of this dissertation is that it has performed such a sensitivity analysis on a cohort study, whereas previous studies to determine the impact of different ethnicity measures on study results have examined population rates. This can provide useful guidance in the selection of method used to measure ethnicity in future cohort studies.

The Unequal Treatment study has produced likely evidence of unequal treatment of Māori with ischaemic heart disease. In an attempt to effect positive change, this data may be presented in a range of forums, in written publications and to a range of specialists in the field; some of whom may not be prepared to accept evidence of inequality. The data therefore must be robust enough to withstand possible challenge of epidemiological methods used. If questioned on the method used to measure ethnicity, it is useful to be able to articulate the range of results produced with the use of different methods. This is a particular strength of this study.

Choice of Method for Future Analyses

The original aims of the Unequal Treatment study were to determine the presence of inequities in procedure receipt and mortality and also to ascertain the contribution of co-morbidities to any disparity detected. Using the ever Māori method, inequalities were identified between Māori and non-Māori and while they diminished slightly when co-morbidities were controlled for, the inequality persisted. This finding did not change when different methods were used to measure ethnicity.

Overall, the method of choice in measuring ethnicity in a cohort study might depend largely on practical considerations and resources available. Maximising study power for Māori is always an issue, and this might lend choice of method towards that which produces the largest number of Māori, in this case the ever Māori method. To maximise study power using the ever Māori method, extended time periods over which to draw data from, and multiple sources of data can be used. In this study, the

maximum time period possible within resource limits was used; hospitalisation data from 1988 to 2004 (earlier data is not readily available), and mortality data from the start of the study (2000) to 31 December 2006. More recent mortality data was not available at the time of data analysis. The use of mortality data to assign ethnicity when the outcome of interest is mortality should be carefully considered. As mentioned earlier, this may bias results towards a slightly higher level of mortality for Māori.

This study has provided useful information for which to guide future analyses in the Unequal Treatment ischaemic heart disease programme and may also be helpful in the design of other cohort studies. Over the time period for which this study was conducted, and for this particular condition (ischaemic heart disease), it does not matter greatly which method is used to measure ethnicity. The choice of method used might depend on practical issues, data availability, or it may depend on the philosophical basis of the study.

Upholding the statistical rights of indigenous peoples provides the moral imperative for developing robust epidemiological practices. The colonial history of Aotearoa has necessitated that indigenous rights require constant assertion in a modern context. As tangata whenua of this country, Māori have the right to good health and healthy conditions, and the right to health data of the highest possible quality. The imbalance of power and control and consequent unequal distribution of privilege and disadvantage in New Zealand society has created and maintained persistent disparities in health between Māori and non-Māori citizens. These inequities are unfair, unjust and unacceptable (Woodward & Kawachi, 2000). The Treaty of Waitangi places an obligation on the New Zealand government to remedy past mistakes through measures that will benefit Māori (Durie, 1998), and therefore an obligation to pursue equity in health.

Kaupapa Māori in research can provide the mechanism by which indigenous needs and demographic circumstances are prioritised in the generation of health data. Self-determination and autonomy lie at the centre of Kaupapa Māori research, and in this context, entails that Māori have the right to count and be counted (Te Rōpū Rangahau Hauora a Eru Pōmare, 2000).

This dissertation has contributed to the field of Kaupapa Māori Epidemiology. Using a Kaupapa Māori 'lens', it has scrutinised, challenged and reassessed four different measures of ethnicity for their appropriation to the health data of indigenous population of Aotearoa.

APPENDIX ONE

Population Denominators

Denominators used in generating population rates data are derived from the 2001 census usually resident population counts. Data given are for the Māori ethnic group (prioritised ethnicity). Non-Māori data are determined by subtracting Māori population counts from total population.

http://search.stats.govt.nz/search?w=census%202001%20population

2001 Census national summary – tables:
table 2 – total population by age
table 3a – Māori age group by sex

Table A1. Population denominators derived from 2001 census usually resident population counts

Five year age group	total	Māori	Non-Māori
0-4	270,801	67,563	203,238
5-9	286,203	66,114	220,089
10-14	290,739	62,805	227,934
15-19	265,281	49,527	215,754
20-24	239,784	42,096	197,688
25-29	246,900	40,164	206,736
30-34	279,279	39,249	240,030
35-39	297,462	38,322	259,140
40-44	285,618	32,856	252,762
45-49	251,787	25,092	226,695
50-54	236,169	19,473	216,696
55-59	182,262	13,827	168,435
60-64	154,569	11,550	143,019
65-69	127,914	7,941	119,973
70-74	118,260	5,070	113,190
75-79	94,503	2,688	91,815
80-84	61,110	1,218	59,892
85 +	48,639	723	47,916
total	**3,737,280**	**526,278**	**3,211,002**

APPENDIX TWO

2001 Māori Standard Population

Population rates are standardised to the 2001 Māori standard population. These weightings are derived from the 2001 census usually resident population for the Māori ethnic group, Statistics New Zealand.[xvii]

Table A2. Percentage of 2001 Māori standard population in each age group

Age group (years)	2001 Māori standard population
0-4	12.84
5-9	12.56
10-14	11.93
15-19	9.41
20-24	8.00
25-29	7.63
30-34	7.46
35-39	7.28
40-44	6.24
45-49	4.77
50-54	3.70
55-59	2.63
60-64	2.19
65-69	1.51
70-74	0.96
75-79	0.51
80-84	0.23
85+	0.14
Total	**100.0**

[xvii] Table 3. URL: http://search.stats.govt.nz/search?w=census%202001. Accessed online 19 October 2009

REFERENCES

Abel, S., Gibson, D., Ehau, T., & Leach, D. T. (2005). Implementing the Primary Health Care Strategy: a Māori Health Provider Perspective. *Social Policy Journal of New Zealand*(25).

Ajwani, S., Blakely, T., & Robson, B. (2004). Unlocking the numerator-denominator bias III: adjustment ratios byethnicity for 1981-1999 mortality data. The New Zealand Census-Mortality Study. *New Zealand Medical Journal, 116*(6).

Ajwani, S., Blakely, T., Robson, B., Atkinson, J., Fawcett, J., & Kiro, C. (2003a). *Unlocking the numerator-denominator bias for the 1980s and 1990s*. Wellington: Department of Public Health, Wellington School of Medicine and Health Sciences, University of Otago.

Ajwani, S., Blakely, T., Robson, B., Atkinson, J., & Kiro, C. (2003b). Unlocking the numerator-denominator bias III: Adjustment ratios for 1981-1999 mortality data. The New Zealand Census-Mortality Study. *New Zealand Medical Journal, 116*, 1175.

Ajwani, S., Blakely, T., Robson, B., Tobias, M., & Bonne, M. (2003c). *Decades of disparity: Ethnic mortality trends in New Zealand 1980-1999.* http://www.moh.govt.nz/moh.nsf/pagesmh/2355?Open. Wellington: Ministry of Health and University of Otago.

Allan, J. (2001). *Classification and Issues: Review of the measurement of ethnicity*. Wellington: Statistics New Zealand.

Altman, D. G. (1991). *Practical Statistics for Medical Research*. London: Chapman and Hall.

Baker, M., Zhang, J., Howden-Chapman, P., Blakely, T., Saville-Smith, K., & Crane, J. (2006). *Housing, crowding and health study: characteristics of cohort members and their hospitalisations, February 2003 to June 2005*. Wellington: He Kainga Oranga/ Housing and Health Research Programme, Wellington School of Medicine and Health Sciences.

Beaglehole, R., Bonita, R., & Kjellstrom, T. (2006). *Basic Epidemiology 2nd Edition*. Geneva: World Health Organisation.

Bishop, R. (1998). Freeing ourselves from neo-colonial domination in research: a Māori approach to creating knowledge. *Qualitative studies in Education 11*(2), 199-219.

Bishop, R., & Berryman. (2006). *Culture Speaks: Cultural relationships and classroom learning*. Wellington: Huia Publishers.

Blakely, T. (2002a). *Anonymous and probabilistic linkage of census and mortality dat: the New Zealand Census-Mortality Study*. Wellington: Department of Public Health, Wellington School of Medicine and Health Sciences, University of Otago.

Blakely, T. (2002b). Measuring Māori health status accurately - more needs doing. *New Zealand Medical Journal, 115*(1151), 149-150.

Blakely, T., Atkinson, J., & Fawcett, J. (2008). Ethnic counts on mortality and census data (mostly) agree for 2001-2004; New Zealand Census Mortality Update. *New Zealand Medical Journal, 121*(1281).

Blakely, T., Salmond, C., & Woodward, A. (1999). *Anonymous record linkage of 1991 census records and 1991-94 mortality records: The New Zealand*

Census-Mortality Study. Wellington: Department of Public Health, Wellington school of Medicine, University of Otago.

Blakely, T., Shaw, C., Atkinson, J., Tobias, M., Bastiampillai, N., & Sloane, K. (in press). *CancerTrends: Trends in Incidence by Ethnic and Socioeconomic Group, New Zealand 1981-2004*. Wellington: University of Otago and Ministry of Health.

Bramley, D., Riddell, T., Crengle, S., Curtis, E., Harwood, M., Nehua, D., et al. (2004a). A call to action on Māori cardiovascular health. *Journal of New Zealand Medical Association, 117*(1197).

Braun, L. (2002). Race, ethnicity, and health. Can genetics explain disparities. *Perspectives in Biology and Medicine, 5*(2), 159-174.

Broughton, J. (1993). 'Being Māori'. *New Zealand Medical Journal*(106), 506-508.

Buchard, E. G., Ziv, E., Coyle, N., Gomez, S. L., Tang, H., Karter, A. J., et al. (2003). The importance of race and ethnic background in biomedical research and clinical practice. *New England Journal of Medicine, 348*(12), 1170-1175.

Callister, P. (2008). *Skin colour: Does it matter in New Zealand? Working paper*. Wellington: Victoria University.

Callister, P., Galtry, J., & Didham, R. (2009). *Skin cancer and Vitamin D: should skin colour or ethnicity be the main variable for communicating health promotion messages?* : Institute of policy Studies Working Paper 09/14 Dec2009.

Carter, K., Hayward, M., Blakely, T., & Shaw, C. (2009). How much and for whom does self-identified ethnicity change over time in New Zealand? Results from a longitudinal study. *Social Policy Journal of New Zealand*(36), 32.

CERD. (2007). Consideration of reports submitted by States Parties under Article 9. *Consideration of reports submitted by States Parties under Article 9 of the Convention - Concluding observations of the Committee on the Elimination of Racial Discrimination* Retrieved 5 February, 2008

Commission on Social Determinants of Health. (2008). *Closing the gap in a generation: health equity through action on the social determinants of health. Final report on the social determinants of health*. Geneva: World Health Organisation.

Cormack, D., & Harris, R. (2009). *Issues in monitoring Māori health and ethnic disparities: an update* Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare.

Cormack, D., Robson, B., Purdie, G., Ratima, M., & Brown, R. (2005). *Access to Cancer Services for Māori: A report prepared for the Ministry of Health*. Wellington: Ministry of Health.

Cram, F. (1993). *Ethics in Māori Research: Working Paper.* Paper presented at the Cultural Justice and Ethics, proceedings of a Symposium at the Annual Conference of the New Zealand Psychological Society, Victoria University, Wellington.

Cram, F. (2004a). A 'Parallel Process' beginning a constructive conversation about Māori methodology. *Journal of Bioethical Inquiry, 1*(1), 14-19.

Cram, F. (2009). Maintaining indigenous voices. In D. Mertens & P. Ginsberg (Eds.), *Handbook of Social Research Ethics* (pp. 308-322). California, USA: Sage Publications Inc.

Curtis E, W. C., Wall M (2005). The epidemiology of breast cancer in Māori women in Aotearoa New Zealand: Implications for ethnicity data analysis. *Journal of New Zealand Medical Association, 118*(1209).

Davis, P., Lay-Yee, R., Dyall, L., Briant, R., Sporle, A., Brunt, D., et al. (2006). Quality of hospital care for Māori patients in New Zealand: retrospective cross-sectional assessment. *Lancet, 367*, 1920-1925.

Department of Statistics. (1993). *New Zealand Standard Classification of Ethnicity*. Wellington: Department of Statistics.

Durie, M. (1998). Te kawenata o Waitangi: the application of the Treaty of Waitangi to health. In M. Durie (Ed.), *Whaiora: Māori Health Development 2nd edition* (pp. 81-97). Auckland: Oxford University Press.

Durie, M. (2003b). The health of indigenous peoples. *BMJ, 326*, 510-511.

Edwards, S., McManus, V., & McCreanor, T. (2005). Collaborative research with Māori on sensitive issues: the application of tikanga and kaupapa in research on Māori Sudden Infant Death Syndrome. *Social Policy Journal of New Zealand*(25).

Fawcett, J., Atkinson, J., Herd, P., & Blakely, T. (2008). *Record linkage of Census and mortality 2000-2004 records: New Zealand Census-Mortality technical report no.6*. Wellington: Department of Public Health, University of Otago, Wellington.

Frank, R. (2007). What to make of it? The (re)emergence of a biological conceptualization of race in health disparities research. *Social Science and Medicine, 64*(10), 1977-1983.

Graham, P., Jackson, R., Beaglehole, R., & Boer, G. d. (1989). The validity of Māori mortality statistics. *New Zealand Medical Journal, 102*(864), 124-126.

Greenland, S. (1996). Basic methods for sensitivity analysis of biases. *International Journal of Epidemiology, 25*(6), 1107-1116.

Harris, R., Keefe, V., Reid, P., & Robson, B. (2000). Impact of changes in the death registration process upon Māori mortality statistics [letter]. *New Zealand Medical Journal, 111*(19).

Harris, R., Purdie, G., Robson, B., Wright, C., Zhang, J., & Baker, M. (2007). Estimating Māori hospitalisations and cancer registrations: Appendix 3. In B. Robson & R. Harris (Eds.), *Hauora: Māori Standards of Health IV. A study of the years 2000-2005*. Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare.

Harris, R., Robson, B., Curtis, E., Purdie, G., Cormack, D., & Reid, P. (2007). Māori and non-Māori differences in caesarean section rates: a national review. *The New Zealand Medical Journal, 120*(1250).

Harris, R., Robson, B., Reid, P., & Keefe, V. (1997). *CHE cultural reviews: Ethnicity data collection - error rates and training effectiveness, Report to the Central Regional Health Authority*. Wellington Te Rōpū Rangahau Hauora a Eru Pōmare, Wellington School of Medicine, University of Otago.

Harris, R., Tobias, M., Jeffreys, M., Waldegrave, K., Karlsen, S., & Nazroo, J. (2006a). Effects of self-reported racial discrimination and deprivation on Māori health and inequalities in New Zealand: Cross-sectional study. *The Lancet, 367*, 2005-2009.

Harris, R., Tobias, M., Jeffreys, M., Waldegrave, K., Karlsen, S., & Nazroo, J. (2006b). Racism and health: the relationship between experience of racial discrimination and health in New Zealand. *Social Science and Medicine, 63*(6), 1428-1441.

Henry, E., & Pene, H. (2001). Kaupapa Māori: Locating indigenous ontology, epistemology and methodology in the academy. *Organization: Speaking Out, 8*(2), 234-242.

Herbert, A. (2002). Bicultural partnerships in clinical training and practice in Aotearoa/New Zealand. *New Zealand Journal of Psychology, 31*.

Hill, S., & Sarfati, D. (2010). Ethnic disparities in treatment of Māori and non-Māori New Zealanders with colon cancer (in press)

Hunt, H., Morgan, N., & Teddy, L. (2001). Barriers to and supports for success for Māori students in the Psychology Department at the University of Waikato. University of Waikato.

Hunt, P. (2006). The human right to the highest attainable standard of health: new opportunities and challenges. *Transactions of the Royal Society of Tropical Medicine and Hygiene, 100*, 603-607.

IRI (International Research Institute for Māori and Indigenous Education), & Te Rōpū Rangahau Hauora a Eru Pōmare. (2000). *Māori Research Development: Kaupapa Māori Principles and Practices - a Literature Review. A report prepared for Te Puni Kōkiri*. Auckland: University of Auckland.

Jackson, M. (1996). *Māori health research and Te Tiriti o Waitangi.* Paper presented at the Hui whakapiripiri: a hui to discuss strategic directions for Māori health research, Wellington School of Medicine: Te Rōpū Rangahau Hauora a Eru Pōmare.

Jeffreys, M., Stevanovic, V., Tobias, M., Lewis, C., Ellison-Loschmann, L., Pearce, N., et al. (2005). Ethnic inequalities in cancer survival in New Zealand: linkage study. *Research and Practice, 95*(5), 834-837.

Jones, C. (2000). Levels of racism: a theoretic framework and a gardener's tale. *American Journal of Public Health, 90*(8), 1212-1215.

Jones, C., Truman, B., & Elam-Evans, L. (2008). Using 'socially assigned race' to probe white advantages in health status. *Ethnicity and Disease, 18*, 496-504.

Jones, C. P., Truman, B. I., Elam-Evans, L. D., Jones, C. A., Jones, C. Y., Jiles, R., et al. (2008). Using "socially assigned race" to probe white advantages in health status. *Ethnicity and Disease, 18*, 496-504.

Kaplan, J., & Bennet, T. (2003). Use of race and ethnicity in biomedical publication. *Journal of the American Medical Association, 289*(20), 2709-2716.

Kaufman, J. S. (1999). How inconsistencies in racial classification demystify the race construct in public health statistics. *Epidemiology, 10*(2), 101-103.

Kaufman, J. S., & Cooper, R. S. (2002). Commentary: Considerations for use of racial/ethnic classification in etiologic research. *American Journal of Epidemiology, 154*(4), 291-298.

Keefe, V., Ormsby, C., & Robson, B. (1995). Kaupapa Māori meets retrospective cohort. *He Pukenga Kōrero, 5*, 12-17.

Kennedy, P. (2007). *A guide to Econometrics 5th edition*: Blackwell Publishing.

Krieger, N. (2000). Counting accountably: implications of the new approaches to classifying race/ethnicity in the 2000 Census. *American Journal of Public Health, 90*(11), 1687-1689.

Krieger, N. (2001). A glossary for social epidemiology. *Journal of Epidemiology and Community Health, 55*(693-700).

Krieger, N. (2010). The science and epidemiology of racism in health: racial/ethnic categories, biological expressions of racism, and the embodiment of inequality. An ecosocial perspective. In I. Whitmarsh & D. Jones (Eds.), *What's the use of race? Modern governance and the biology of difference*. London: The MIT press.

Krieger, N., Chen, J. T., Waterman, P. D., Rehkopf, D. H., Yin, R., & Coull, B. A. (2006). Race/ethnicity and changing US socioeconomic gradients in breast

cancer incidence: California and Massachusetts, 1978-2002 (United States). *Cancer Causes and Control, 17*, 217-226.

Kukutai, T. (2009). In search of ethnic New Zealanders: National naming in the 2006 census. *Social Policy Journal of New Zealand*(36), 46-62.

Kukutai, T., & Callister, P. (2009). A 'main' ethnic group? Ethnic self-prioritisation among New Zealand youth. *Social Policy Journal of New Zealand*(36), 16-31.

MacDonald, J. (1999). The culture of health and illness. In K. Dew & P. Davis (Eds.), *Health and Society in Aotearoa New Zealand* (pp. 111-127). Melbourne: Oxford University Press.

McKinley, E., Waiti, P. M., & Bell, B. (1992). Language, Culture and Science Education. *International Journal of Science Education, 14*(5), 579-595.

McLeod, D. (2006). Ethnicity data and primary care in New Zealand: lessons from the Health Utilisation Research Alliance (HURA) study. *New Zealand Medical Journal, 119*(1231).

McLeod, D., Mansell, J., Harris, R., Bailey, T., Dowell, A., Robson, B., et al. (2000). The collection of patient ethnicity data: a challenge for General Practice. *New Zealand Family Physician, 27*(3), 51-57.

McNicholas, P., & Barrett, M. (2003). Answering the emancipatory call: an emerging research approach 'on the margins' of Accounting. *Clinical Perspectives on Accounting*.

Mihaere, K. M., Harris, R., Gander, P. H., Reid, P. M., Purdie, G., Robson, B., et al. (2009). Obstructive Sleep Apnea in New Zealand Adults: Prevalence and Risk Factors among Māori and non-Māori. *Sleep, 32*(7), 949-956.

Ministry of Health. (2002b). *He Korowai Oranga*. Wellington: Ministry of Health,.

Ministry of Health. (2002c). *Reducing inequalities in health*. Wellington: Ministry of Health.

Ministry of Health. (2002d). *The New Zealand Health Monitor: A ten-year cycle of health-related surveys*. Wellington: Ministry of Health

Ministry of Health. (2004a). *Ethnicity data protocols for the Health and Disability sector*. Wellington: Ministry of Health.

Ministry of Health. (2006a). *Tatau Kahukura: Māori Health Chart Book*. Wellington: Ministry of Health.

Ministry of Health. (2007). Report: 'Health inequalities are narrowing' press release: 23 August 2007: Ministry of Health.

Ministry of Health. (2008a). *Presenting ethnicity: comparing prioritised and total response ethnicity in descriptive analyses of New Zealand Health Monitor surveys*. Wellington: Ministry of Health.

Ministry of Health. (2008b). *A Portrait of Health. Key results of the 2006/07 New Zealand Health Survey*. Wellington: Ministry of Health.

Ministry of Health. (2010). *Tatau Kahukura: Māori Health Chart Book 2010, 2nd Edition*. Wellington: Ministry of Health.

Ministry of Health, & University of Otago. (2006e). *Decades of Disparity III: Ethnic and socioeconomic inequalities in mortality, New Zealand 1981-1999*. Wellington: Ministry of Health.

Moewaka-Barnes, H. (2000). *Kaupapa Māori: Explaining the Ordinary*. Auckland: Whariki Research Group, University of Auckland.

New Zealand Health Information Service. (2004b). *Mortality Collection Data Dictionary version 1.2*. Wellington: Ministry of Health.

Orange, C. (2004). *The Treaty of Waitangi*. Wellington Bridget Williams Books.

Owen, V. (2001). Whanake Rangatahi: Programmes and Services to Address Māori Youth Offending. *Social Policy Journal of New Zealand*(16).

Paine, S.-J., Gander, P. H., Harris, R. B., & Reid, P. (2007). Prevalence and consequences of insomnia in New Zealand: disparities between Māori and non-Māori. *Australian and New Zealand Jounal of Public Health, 29*(1), 22-28.

Pearce, N. (1999). Epidemiology as a population science. *International Journal of Epidemiology, 28*, S1015-1018.

Pearce, N., & A, M. (2004). *Occupation in routinely collection national health data. Report to the New Zealand Health Information Service*. Wellington: Centre for Public Health Research, Massey University.

Pearce, N., Foliaki, S., Sporle, S., & Cunningham, C. (2004). Genetics, race, ethnicity and health. *British Medical Journal, 328*, 1070-1072.

Pipi, K. (2004). A Research Ethic for studying Māori and Iwi Provider Success. *Social Policy Journal of New Zealand*(23).

Pool, D. I. (1991). *Te iwi Māori: a New Zealand population, past, present and projected*. Auckland: Auckland University Press.

Public Health Intelligence. (2001a). *Monitoring ethnic inequalities in health*. Wellington: Public Health Occasional Bulletin no.4, Public Health Intelligence, Ministry of Health.

Reid, P. (1999a). Te Pupuri i te ao o te Tangata Whenua. In P. Davis & K. Dew (Eds.), *Health and Society in Aotearoa New Zealand* (pp. 51-62). Auckland, New Zealand: Oxford University Press.

Reid, P. (1999b). Nga Mahi Whakahaehae a te Tangata Tiriti. In P. Davis & K. Dew (Eds.), *Health and Society in Aotearoa New Zealand* (pp. 51-62). Auckland: Oxford University Press.

Reid, P. (2008). *'Stats R Us'*. Paper presented at the Hui Whakapiripiri, Health Research Council National Hui.

Reid, P., & Cram, F. (2005). Connecting health, people and country in Aotearoa New Zealand. In P. Davis & K. Dew (Eds.), *Health and Society in Aotearoa New Zealand 2nd edition* (pp. 33-48). Auckland: Oxford University Press.

Reid, P., & Robson, B. (2007). Understanding health inequities. In B. Robson & R. Harris (Eds.), *Hauora: Māori Standards of Health IV. A study of the years 2000-2005* (pp. 3-10). Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare.

Reid, P., Robson, B., & Jones, C. P. (2000). Disparities in Health: Common myths and uncommon truths. . *Pacific Health Dialogue, 7*(1), 38-47.

Robson, B. (2002). *Mana whakamārama. Equal explanatory power.* . Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare.

Robson, B. (2005). *Meeting the Statistical Rights of Indigenous Peoples*. Paper presented at the IAOS Satellite Meeting.

Robson, B., Cram, F., Purdie, G., & Simmonds, S. (2007). Age Standardisation - an Indigenous Standard? *Emerging themes in Epidemiology, 4*(3), 1-11.

Robson, B., & Harris, R. (Eds.). (2007). *Hauora: Māori Standards of Health IV, a study of the years 2000-2005*. Wellington, New Zealand: Te Rōpū Rangahau Hauora a Eru Pōmare.

Robson, B., & Purdie, G. (2007). Appendix One: Methods. In B. Robson & R. Harris (Eds.), *Hauora: Māori Standards of Health IV, a Study of the Years 2000-2005*. Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare.

Robson, B., Purdie, G., & Cormack, D. (2006). *Unequal Impact: Māori and non-Māori Cancer Statistics 1996-2001*. Wellington: Ministry of Health.

Robson, B., Purdie, G., & Cormack, D. (in press). *Unequal Impact II: Māori and non-Māori cancer Statistics by Deprivation and Rural-Urban Status 2002-2006.* . Wellington: Ministry of Health.

Robson, B., & Reid, P. (2001). *Ethnicity matters: review of the measurement of ethnicity in official statistics. Māori perspectives paper for consultation.* http://www.stats.govt.nz/analytical-reports/review-measurement-ethnicity/maori-perspective. Wellington: Statistics New Zealand.

Robson, B., Reid, P., Keefe-Ormsby, V., Pere, L., Malcolm, G., Scott, N., et al. (1996). *A method for auditing the collection of ethnicity data in hospital statistics: a report to Te Kete Hauora, Ministry of Health, Wellington*. Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare.

Royal Commission on Social Policy. (1988). *The April Report*. Wellington: Royal commission on Social Policy.

Rubie-Davies, C., Hattie, J., & Hamilton, R. (2006). Expecting the best for students: teacher expectations and academic outcomes. *British Journal of Educational Psychology, 76*(3), 429-444.

Saltelli A et al. (2008). *Global Sensitivity Analysis. The Primer*: John Wiley and Sons.

Senior, P. A., & Bhopal, R. (1994). Ethnicity as a variable in epidemiological research. *British Medical Journal*(309), 327-330.

Shaw, C., Atkinson, J., & Blakely, T. (2009). (Mis)classification of ethnicity on the New Zealand Cancer registry: 1981-2004. *New Zealand Medical Journal, 122*(1294), 10-22.

Shaw, C., Atkinson, J., Blakely, T., Stanley, J., & Sloane, K. (2009). *Cancer Trends Technical report: linkage of census and cancer registrations 1981-2004*. Wellington: University of Otago.

Simmonds, S., Robson, B., Cram, F., & Purdie, G. (2008). Kaupapa Māori Epidemiology. *Australasian Epidemiologist, 15*(1), 3-6.

Simon, P. (2007). The measurement of racial discrimination: The policy use of statistics. *International Social Science Journal, 57*(183), 1-4.

Simpson, L., & Akinwale, B. (2007). Quantifying stability and change in ethnic group. *Journal of Official Statistics, 23*(2), 185-208.

Smith, G. (1997). *Kaupapa Māori: Theory and Praxis.* University of Auckland, Auckland.

Smith, G. H. (2002). *Beyond Freire's Political Literacy: From Conscientisation to Transformative Praxis.* Paper presented at the AERA Conference, New Orleans.

Smith, G. H. (2003). *Indigenous Struggle for the Transformation of Education and Schooling.* Paper presented at the Alaskan Federation of Natives Convention, Anchorage, Alaska, US.

Smith, L. (1999a). *Kaupapa Māori methodology: Our power to define ourselves.* http://www.hauora.com/research (Seminar Presentation). British Columbia: University of British Columbia.

Smith, L. T. (1999b). *Decolonizing Methodologies: Research and Indigenous Peoples*. London & New York: Zed Books.

Smith, L. T. (2005). Building a Research Agenda for Indigenous Epistemologies and Education. *Anthropology and Education Quarterly, 36*(no.1), 93-95.

Smith, L. T. (2007). The native and the neoliberal down under: Neoliberalism and "endangered authenticities". In de la Cadena M & Starnberg O (Eds.), *Indigenous Experience Today*. Oxford, UK: Berg.

Statistics New Zealand. (1999). *Measuring Māori ethnicity in the New Zealand census*. Wellington: Statistics New Zealand.

Statistics New Zealand. (2004). *Report of the Review of the Measurement of Ethnicity*. Wellington: Statistics New Zealand.

Statistics New Zealand. (2005a). *Statistical Standard for Ethnicity 2005*. Wellington: Statistics New Zealand.

Statistics New Zealand. (2006a). Māori population estimates tables (Publication., from Statistics New Zealand: http://www.stats.govt.nz/tables/maori-popn-est-tables.htm

Statistics New Zealand. (2006b). National population estimates tables (Publication. Retrieved 4 May 2007, from Statistics New Zealand: http://www.stats.govt.nz/tables/nat-pop-est-tables.htm

Stevens, W., Stevens, G., Kolbe, J., & Cox, B. (2008). Ethnic differences in the management of lung cancer care. *Journal of Thoracic Oncology, 3*(3), 237-244.

Swan, J., Lillis, S., & Simmons, D. (2006). Investigating the accuracy of ethnicity data in New Zealand hospital records: still room for improvement. *New Zealand Medical Journal, 119*(1239).

Taki, M. (1996). *Kaupapa Māori and Contemporary Iwi Resistance.* University of Auckland, New Zealand, Auckland.

Te Rōpū Rangahau Hauora a Eru Pōmare. (2000). Counting for nothing: Understanding the issues in monitoring disparities in health. *Social Policy Journal of New Zealand, 14*, 1-16.

Te Rōpū Rangahau Hauora a Eru Pōmare. (2007). Unequal Treatment - the role of Health Services, Draft Technical Report March 2007.

Te Rōpū Rangahau Hauora a Eru Pōmare. (2008). *Unequal Treatment II - the role of Health Services, Research Proposal Application to the Health Research Council of New Zealand.* . Wellington: Te Rōpū Rangahau Hauora a Eru Pōmare, Otago University, Wellington.

Thomas, D. (2000). Assessing ethnicity in New Zealand health research. *New Zealand Medical Journal, 114*, 86-88.

Tobias, M. (2001). *Monitoring Ethnic Inequalities in Health*. Wellington: Ministry of Health.

Tobias, M., Sexton, K., Mann, S., & Sharpe, N. (2006). How low can it go? Projecting ischaemic heart disease mortality in New Zealand to 2015. *New Zealand Medical Journal, 119*(1232).

Travassos, C., & Williams, D. R. (2007). The concept and measurement of race and their relationship to public health: a review focused on Brazil and the United States. *Cadernos de Saude Publica, 23*(3), 660-678.

United Nations. (2007). *United Nations Declaration on the Rights of Indigenous Peoples*. Geneva.

Viela, A. J. (2008). Odds ratios and risk ratios: what's the difference and why does it matter? *Southern Medical Journal, 101*(7), 730-734.

Walker, P. (2004). Partnership Models within a Māori Social-service Provider. *Internation Journal of Social Welvare, 13*(2), 158-169.

Westbrooke, I., Baxter, J., & Hogan, J. (2001). Are Māori Underserved for Cardiac Interventions? *New Zealand Medical Journal, 114*(1143), 484-487.

Williams, D. R. (2008). Discrimination and racial disparities in health: evidence and needed research. *Journal of Behavioural Medicine, 32*(1).

Williams, H. W. (1992). Dictionary of the Māori Language, seventh edition. Wellington: GP Publications.

Woodward, A., & Kawachi, I. (2000). Why reduce health inequalities? *Journal of Epidemiology and Community Health, 54*, 923-929.

Zygadlo, F. K., McIntosh, A., Matunga, H. P., Fairweather, J., & Simmons, D. (2003). *Māori Tourism: Concepts, Characteristics and Definition*. Christchurch: Lincoln University.